First Report of the Woburn Experimental Fruit Farm. 1897.

THE DUKE OF BEDFORD
AND
SPENCER U. PICKERING, F.R.S.

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WOBURN EXPERIMENTAL FRUIT FARM.

REPORT

ON THE

WORKING AND RESULTS

OF THE

WOBURN EXPERIMENTAL FRUIT FARM

SINCE ITS ESTABLISHMENT.

BY

The DUKE of BEDFORD

AND

SPENCER U. PICKERING, F.R.S.

FIRST REPORT.

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TABLE OF CONTENTS.

PAGE

INTRODUCTORY - - - - - - - - 1

PART I.—DESCRIPTION OF THE GROUND AND THE EXPERIMENTS - - - - - 4

THE GROUND AND SOIL - - - - - 4

MANURES USED - - - - - - 9

DESCRIPTION OF THE EXPERIMENTS - - - 12

Experiments with dwarf apple trees. Treatment of branches, roots, and surface soil; manuring, and planting - - - - - - - 12

Experiments with standard apple trees - - 18

Different methods of training - - - 19

Collection of varieties of apple trees on different stocks - - - - - - 20

Collection of varieties of strawberries - - 22

Demonstration Plots—Farmers' - - - 24

Growers' - - - 28

Cottagers' - - - 31

Experiments on the arrangement of trees - - 33

Fruit-tree hedges - - - - - 35

Experiments on dressing strawberries during fruiting - 35

Collection of, and manurial treatment of gooseberries - 37

" " " currants and raspberries - 38

Collection of pears on different stocks - - 39

" plums - - - - - 40

" cherries - - - - - 40

" perry pears - - - - 40

" cider apples - - - - 42

" local apples - - - - 42

" Italian pears - - - - 43

Experiments on cutting back on planting - - 44

" sheltering of blossoms - - 44

" different methods of pruning - 44

" the effect of bad planting - - 45

" the cross-fertilisation of apples - 45

Collection of various berries - - - 47

" trees and shrubs - - - 47

" plants of special interest - - 51

Experiments on canker of apple trees - - 53

" dressing strawberries - - - 54

Repetition experiments on cutting back - - 55

Collection of peaches, nectarines and apricots - 55

Kashmiri apples - - - - - 56

PAGE

PART II.—EXPERIMENTAL RESULTS - - - 57

EXPERIMENTS CHIEFLY ON APPLE TREES - - 57

Methods of examination - - - 58

Leaf-size - - - - - - 58

Total leaf-area - - - - - 67

Leaf-weight - - - - - 68

Wood-growth - - - - - 68

Number of shoots - - - - 74

Crops - - - - - - 77

Agreement between the different methods - 79

Results of different treatment - - - 90

Careless planting and neglect - - - 90

Grass and weeds round trees - - - 97

Cutting back after planting - - - 101

Pruning - - - - - - 108

Root-pruning and lifting - - - - 110

Manures - - - - - - 110

Planting in different seasons - - - 116

,, ,, soils - - - - 117

,, too high and too low - - - 118

EXPERIMENTS ON STRAWBERRIES - - - 121

Different varieties under same treatment - - 121

Same varieties in different parts of the Farm - 138

Effect of liquid dressings - - - - 147

EXPERIMENTS ON POTATOES - - - - 150

Effect of spraying - - - - - 150

,, planting at different times - - - 157

GERMINATIVE POWER OF SEEDS FROM FRUITS OF DIFFERENT SIZES - - - - - 160

OBSERVATIONS ON CANKER IN PLUMS - - 164

A NEW FORM OF EVAPORIMETER - - - 168

METEOROLOGICAL RECORDS - - - - 175

DIFFERENT ARRANGEMENTS OF TREES - - - 181

Appendix A.—Summary of experimental results - - 187

,, B.—Equivalents of English and metric measures - 194

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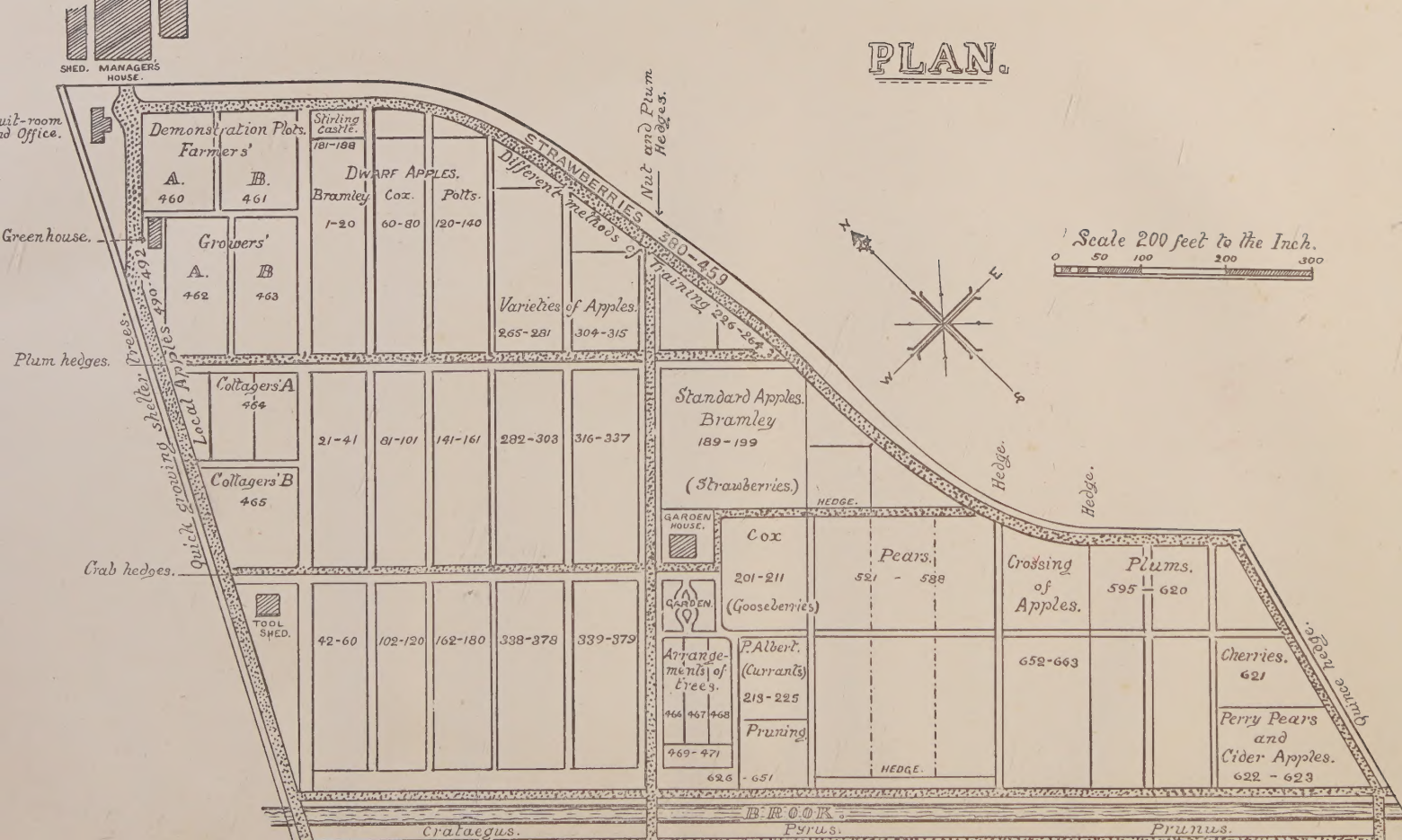

PLAN.
SHED.
MANAGER'S HOUSE.
uit-room
d Office.
Greenhouse.
Plum hedges.
Crab hedges.
Quick growing shelter trees.
Local Apples
490-492
Demonstration Plots.
Farmers'
A. 460
B. 461
Growers'
A. 462
B 463
Stirling castle.
181-188
DWARF APPLES.
Bramley
1-20
Cox.
60-80
Polts.
120-140
Varieties of Apples.
265-281
304-315
STRAWBERRIES.
Different methods of training 295-264
Nut and Plum Hedges.
380-459
Cottagers' A
464
Cottagers' B
465
21-41
81-101
141-161
282-303
316-337
Standard Apples.
Bramley
189-199
(Strawberries.)
HEDGE.
GARDEN HOUSE.
Cox
201-211
(Gooseberries)
GARDEN.
TOOL SHED.
42-60
102-120
162-180
338-378
339-379
Arrangements of trees.
466 467 468
469-471
626 - 651
P. Albert.
(Currants)
213-225
Pruning
Pears.
521 - 588
HEDGE.
Crossing of Apples.
652-663
Plums.
595 - 620
Cherries.
621
Perry Pears and Cider Apples.
622 - 623
Quince hedge.
Hedge.
Hedge.
N
E
S
W
Scale 200 feet to the Inch.
0 50 100 200 300
BROOK.
Crataegus.
Pyrus.
Prunus.

WOBURN EXPERIMENTAL FRUIT FARM.

FIRST REPORT.

1897.

INTRODUCTORY.

An apology is scarcely needed for the foundation of an experimental station for the study of fruit-culture, unless it be that those who found it cannot reasonably expect to see the completion of all which they initiate, or that so many of the investigations undertaken would be exhaustive only, if conducted on a larger scale, and in a greater diversity of soil and climate than can be commanded by any private individual. In the sister science of agriculture, however, we have had such notable examples of what can be accomplished by individual workers, that any such objections must lose much of their force; and we may question whether, in an undertaking of this character, private enterprise is not a desirable substitute for State intervention.

It may not be superfluous to point out clearly that the main object of this experimental station is to ascertain facts relative to the culture of fruit, and to increase our knowledge of, and to improve our practice in this industry. Our object is not to provide a model of a commercial fruit farm, nor to induce farmers to adopt

fruit-farming instead of agriculture. We believe, it is true, that fruit-farming might be successfully extended in this country, and that a certain, though perhaps small percentage of those who now find agriculture an impossibility might be able to gain a fair livelihood by the culture of fruit; but if we are to aid any such extension, it will not be by the direct, or still less by an indiscriminate advocacy of the industry, but by increasing our knowledge of it, both from a scientific and practical point of view, so that those who may embark on it may be able to equip themselves better for their profession than they now can.

Owing to the shortness of the time which has elapsed since the beginning of our work, and the length of time required for experiments on any form of trees, our present report can consist of little else than a description of the ground, and of the subjects which are being investigated. Yet a certain number of results have already been obtained, and though these are in many cases incomplete, and though our conclusions from them must, therefore, be liable to future modification, still they even now present many features of interest and practical importance, and are, moreover, eminently suggestive of the need for investigations of this character.

The details of the measurements and weighings which have been taken are so cumbrous that we have thought it advisable to omit them as far as possible, and to give only the final results; even these, and the necessary discussion of them, may, we fear, prove a stumbling-block to horticulturists, who have, as a rule, not much time for entering into details: we have, therefore, thought it well to add a summary of our results, in the form of an appendix, to the present report.

After careful consideration we have adopted generally the metric system of weights and measures in our work.* This need, however, present no difficulty to readers who are not familiar with the system, for most of our results will take the form of tables of numbers expressing merely the *relative* values of different methods of treatment, and, in cases where actual weights, &c., might be of interest to horticulturists, we have given them in the English, as well as in the metric units. At the end of this report we also give the data for converting the one into the other.

* This was not done, however, till after the ground had been plotted out, so that the size of the plots and distances between the trees are generally represented in round numbers of feet. As we have not thought it necessary, in all cases, to convert these measurements into metres, for the purposes of the present report, we are open to the accusation of inconsistency in this respect.

PART I.—DESCRIPTION OF THE GROUND AND THE EXPERIMENTS.

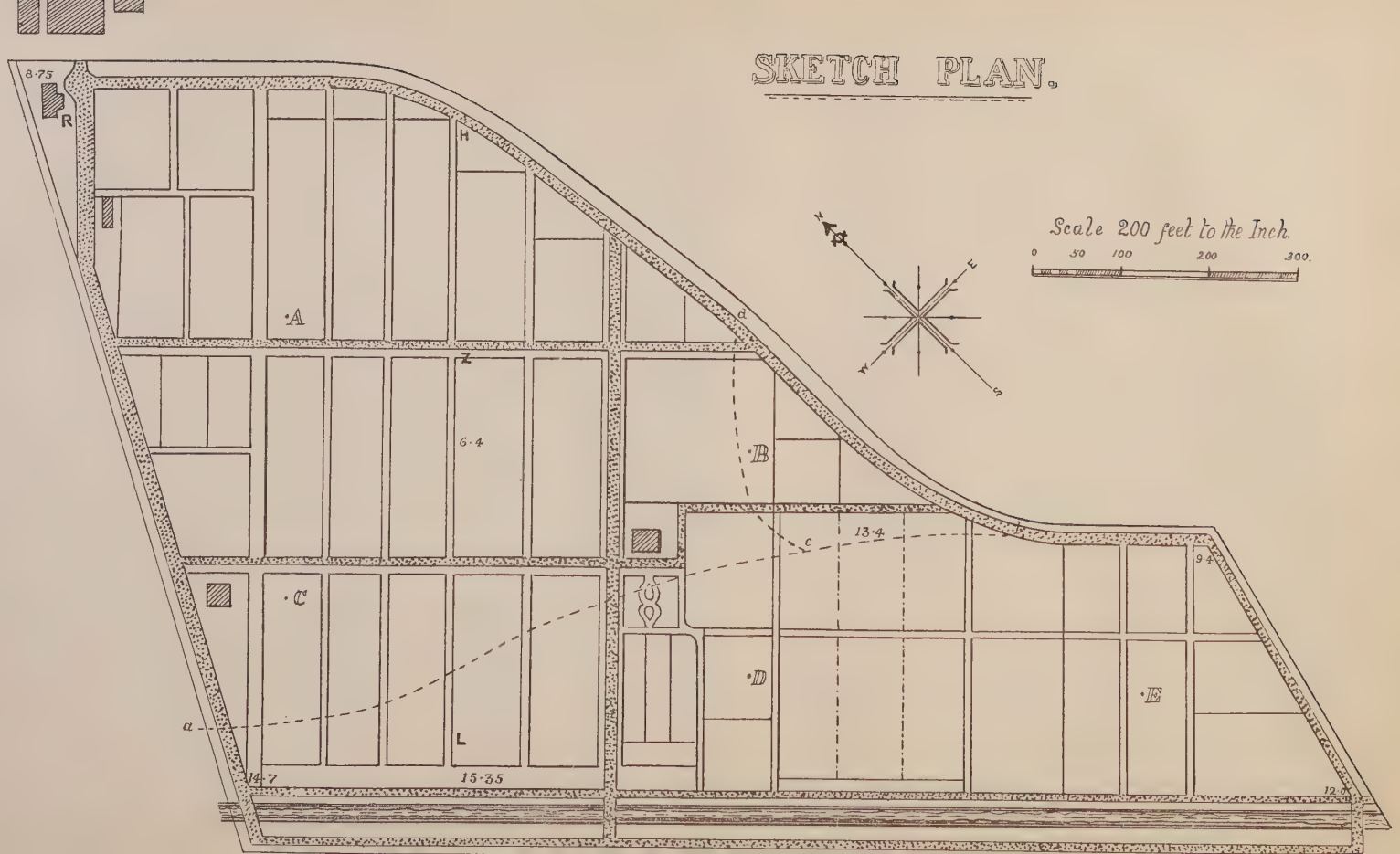
The Ground and Soil.

THE farm consists of a field of 20 acres, situated close to the Ridgmont Station, on the Bletchley and Cambridge line.

Up to June 1894, when the preparation of the ground for fruit-growing was started, this field had been used as arable land for the ordinary rotation of farm crops. The last crop grown on it was a root crop, and from a considerable portion of the ground this was not removed till the following year.

The soil consists of a sandy loam, some 9 or 10 inches in depth, resting on a bed of Oxford clay. Although the soil contains a large proportion of sand, the land would generally be termed very heavy, and as such, indeed, it had a bad reputation amongst the farmers, the water often standing on it in places for weeks together in a wet season. The "heaviness," however, seems due, not to the presence of a large amount of clay in the surface soil, but to the very fine state of division in which much of the sand is present. The tillage to which the ground has now been subjected has very much improved its character, and though a comparatively small amount of rain still renders it unworkable, yet in dry weather it presents as good a tilth as could be desired. Beyond cultivation, and the making of various roads with rubble drains at their edges, nothing has been done to drain the ground: the greater part of it is intersected, it is true, with tile drains 30 feet apart, but as these are sunk well

SKETCH PLAN.


Scale 200 feet to the Inch.
0 50 100 200 300.
N
E
S
W
8·75
R
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A
Z
6·4
B
C
13·4
9·4
D
E
a
L
14·7
15·35
12·6

into the stiff clay, three feet below the surface, they have practically no effect on the surface drainage.

The subsoil consists of a bed of clay of considerable depth. Borings have been sunk in two places to 45 feet below the surface without reaching the bottom of it. At depths below about 10 feet the clay is blue, and in parts very hard. It does not appear to contain any stones, and the surface soil also contains very few (about 2 per cent. of the weight of dried soil).

The ground was all well trenched before any planting was done, and repeated forking and hoeing have been necessary to get rid of the weeds, which were very abundant. Throughout the greater part of the field there is a gentle slope towards a brook, which runs along the south-west side of it.

The height in feet of various parts of the ground below the highest point is marked on the sketch plan opposite. It will be seen that the highest point (marked H) is about 15·4 feet above the road by the brook, the distance from this road being 750 feet, and the average slope, therefore, 1 in 49.

The brook runs between banks, 3 to 4 feet high; it is never dry, and in flood time it occasionally overflows its banks, swamping the lower portion of the ground.

For the chemical analysis of the soil we are indebted chiefly to Dr. A. J. Voelcker, of the Royal Agricultural Society, though for some of the nitrogen determinations we must thank Mr. M. J. R. Dunstan. Five points in the field were selected, marked *A* to *E* in the sketch plan, and round each point, and at a distance of 50 feet from it, the soil was sampled to three depths of 9 inches each. An iron 12 inches square was used for the first depth, and one 6 inches square, for the other depths. After being dried and sifted, portions of

the three samplings round the selected points were mixed, and it is to these mixed samples that the following analyses refer.

TABLE I.—ANALYSIS OF SOIL.

Percentages in the Samples dried at 100° C.

Sample.	Lime.	Carbon Dioxide.	Potash.*	Phosphoric Acid.	Nitrogen.	Sand.
A.						
1st. 9 inches	0·36	0·11	0·25	0·16	0·136	58
2nd. 9 inches	1·12	0·45	0·54	0·13	0·088	32
3rd. 9 inches	3·84	2·28	0·73	0·09	0·060	14
B.						
1st. 9 inches	0·29	0·18	0·20	0·15	0·142	63
2nd. 9 inches	0·33	0·05	0·23	0·16	0·090	58
3rd. 9 inches	0·28	0·05	0·23	0·17	0·066	64
C.						
1st. 9 inches	0·38	0·09	0·29	0·12	0·139	69
2nd. 9 inches	0·29	0·09	0·24	0·10	0·079	60
3rd. 9 inches	0·46	0·09	0·30	0·09	0·076	12
D.						
1st. 9 inches	1·03	0·11	0·60	0·22	0·28	40
2nd. 9 inches	0·87	0·05	0·51	0·20	0·14	20
3rd. 9 inches	0·48	0·07	0·19	0·45	0·08	12
E.						
1st. 9 inches	1·05	0·12	0·63	0·21	0·30	17
2nd. 9 inches	1·07	0·06	0·53	0·15	0·20	23
3rd. 9 inches	0·80	0·07	0·50	0·26	0·13	18
M.						
1st. 9 inches	2·67	1·40	0·43	0·22	0·213	—
2nd. 9 inches	0·62	0·20	0·52	0·11	0·082	—
3rd. 9 inches	0·54	0·05	0·66	0·08	0·061	—
N.						
1st. 9 inches	2·49	1·30	0·27	0·11	0·091	—
2nd. 9 inches	0·46	0·05	0·45	0·11	0·073	—
3rd. 9 inches	0·54	0·10	0·62	0·10	0·049	—

* Determined after ignition.

At the bottom of the table we give two analyses of an arable field at Rothamstead. These we owe to the courtesy of Dr. Bernard Dyer. They both refer to plots in the famous Broadbalk field, where wheat has been grown continuously for half a century. The first (M) is that of the plot which has been dressed every year with 14 tons of farmyard manure to the acre, and may be taken as a fair sample of fertile arable land; and the second (N) is that of the plot which has been unmanured throughout, and in which the soil, especially the upper layer, has become thoroughly exhausted.

Looking at the percentages of potash, phosphoric acid and nitrogen, it will be seen that the samples from the upper portion of our ground (*A*, *B* and *C*) are decidedly poorer than the fertile Rothamstead soil, the food constituents being present in quantities about one-third less; but, except as regards the potash, they do not approach to the state of exhaustion shown by the poorer Rothamstead soil. Our soil may be taken to be on the average one in a moderately fertile condition. In the lower part of the ground, however (*D* and *E*), the food constituents are present in very liberal quantities, and, except as regards the phosphoric acid in the first nine inches, are considerably in excess of those in the richer Rothamstead soil. This portion of our ground must be regarded as being very fertile, and exceptionally rich for arable land.

There can be no doubt, even on an inspection of the field, that it presents considerable variations of soil. The ground to the south-west of the dotted line marked a b c in the sketch plan is darker and more friable than that above it, and the line of demarcation between the two soils can be traced very clearly throughout the field. The percentages of sand found

at the stations *E* and *F*, which are in this darker soil, as compared with those found in the other stations, would alone be sufficient to show the want of uniformity in the ground. It seems probable that the difference has been caused by the repeated overflowing of the brook on to the lower portion of the field in former times. Immediately above the richer portion there is a strip some 50 or 60 feet wide, which appears to consist of lighter and poorer soil than the rest of the ground, this is so, too, as regards the portion marked a b c.

With such differences in composition we must admit that our field is by no means an ideal one for experimental purposes, and that great care will have to be exercised in drawing conclusions from comparative experiments which extend over any large section of the ground.

Owing to the heavy rains in November 1894, very little planting could be done before the close of the year, and much had to be postponed till the following spring. The winter, it will be remembered, was one of exceptional severity, and in our newly trenched ground, saturated with previous rain, the frost penetrated to a depth of 24 inches, while a temperature as low as $-7°$ Fahrenheit was registered on the surface. Such conditions were very trying to trees just planted, or only laid in the ground ready for planting, and it affords a striking evidence of the hardiness of English fruit trees that practically no ill effects were shown by them, the damage being confined to the young stocks destined for grafting. The only fruit tree which appeared with certainty to have suffered was Lane's Prince Albert apple, grown as a standard on the crab stock, in which case the bark and wood of about 50 per cent. of the trees were injured; the injury, however, was temporary,

and nearly all of them have now recovered. (The injured trees, it may be mentioned, were, however, rejected for experimental purposes.) It is noticeable that specimens of the same apple on the paradise stock did not appear to be affected by the frost.

Our trees were further tried by the drought of the succeeding spring and summer. The number of deaths, however, out of 1,800 apple trees in our experimental plots, was only 11,* and these were replaced in the succeeding year by other trees one year older at planting than their predecessors had been.

Manures Used.

Except in a few special cases, no manure was applied to the ground before planting, nor till the autumn of 1895—one year after the trees had been planted.

In order to secure the uniformity essential in experimental work, it has been necessary to use artificial manures instead of dung. The requirements of fruit trees as to their food have not, however, at present been investigated, and it is quite possible that the mixture which we have selected as a normal manure may eventually be found to be inappropriate in its nature, or inadequate in amount. In the absence of the requisite data, we selected a mixture calculated to replace the food constituents in the soil in about the same proportions as those in which they are removed by a crop of apples, although it must be clearly pointed out that such a mixture is not necessarily the one best suited even for apple trees, and still less for fruit trees generally.

* Of these, two were trees which had purposely been planted too high.

Combining the analyses published by E. Wolff ("Aschen Analysen," Berlin, 1871, p. 129), and by J. König ("Die menschlichen Nahrungs u. Genussmittel," Berlin, 1893, p. 815), we find that fresh apples contain about—

Potash (K_2O)	- - -	0·13 per cent.
Phosphoric acid (P_2O_5)	-	0·05 „
Magnesia (MgO)	- -	0·03 „
Soda (NaO)	- -	0·09 „

and, if we take 50 lbs. as a liberal estimate for the average crop of a full-grown bush apple tree, we find that the above constituents of the crop will be replaced by the application to each tree of—

0·13 lbs. of commercial potassium sulphate.
0·21 lbs. „ „ superphosphate of lime.
0·045 lbs. „ „ magnesium sulphate.
0·135 lbs. „ „ sodium nitrate, containing 0·021 lbs. of nitrogen.

For our normal manure we have taken double these quantities, so as to allow for waste by drainage, &c.

Our bush trees have for the most part been planted at a distance of 11 feet from their neighbours, so that there are 360 trees to the acre, and these, when fully grown, may be expected to occupy the ground entirely; the amounts of the various manures in pounds applied per acre will then be those given in the following table, and at present the application is made at the same rate (given, also, in ounces per square yard, and in grams per square metre in the table), but only to a limited area round the tree, this area extending to

a distance some six inches beyond the extension of the roots:—

	Per Acre.	Per Square Yard.	Per Square Metre.
Potassium sulphate - - -	94 lbs.	0·31 ozs.	9·7 grams.
Superphosphate - - -	152 „	0·50 „	15·8 „
Magnesium sulphate - -	32 „	0·11 „	3·3 „
Sodium nitrate - - -	97 „	0·32 „	10·0 „

The area manured will be increased every year, so that after a certain period—when the trees will probably have reached maturity—the whole of the ground will be uniformly manured. For dwarf apples it has been assumed that maturity will be reached when the trees are 15 years old from the graft, and for standard apples when they are 30 years old.

Although the composition of this manure was based on grounds of very doubtful validity, it is probable that the mixture represents a good general manure for most purposes, for it will be found that the relative proportions of the constituents present in it are very similar to those of mixtures which in the experiments of Lawes and Gilbert have yielded some of the best results with a number of farm crops.

In experiments where iron or manganese has been used, the quantity of the former has been ten times that which a crop of apples would remove according to the analyses above mentioned, and manganese has been used in the same quantity as iron.

In all ordinary cases the sodium nitrate was applied by itself in the spring, whereas the other constituents were mixed together, and applied in the autumn.

Where stable manure has been used, the quantity applied has been 12 tons per acre = 5·55 lbs. per square yard, or 3,020 grams per square metre. From the potash, phosphoric acid and nitrogen present, it would appear that about four tons per acre would be the chemical equivalent of our dressing of artificial manure, but eminent agriculturists whom we have consulted are of opinion that dung corresponding to three times its chemical equivalent in artificial manures should be used, in order to supply the same amount of food to the plant.

It may be mentioned that the cost of a dressing of artificial manure, including carriage and application, is about 1*l.* 10*s.* per acre. This would compare very favourably in most cases with the cost of an equivalent of dung.

In the case of our demonstration plots, and other plots where a vigorous growth was a desideratum, the manure has been applied in quantities two and a half times greater than the above, equivalent to an application of 30 tons of stable manure to the acre.

Description of the Experiments.

Plots Nos. 1 *to* 500 *were planted in* 1894-5, *and most of the others in the subsequent season.*

The experiments on different methods of treatment of branches, roots and soil have at present been confined chiefly to apple trees. For the main experiments dwarf apple trees on an English broad-leaved paradise stock were planted in 1894-5. The trees were all three years old when planted, and were as uniform as possible. In

each experiment there are 18 trees in a row, running south-west and north-east. Six of these trees are Bramley's Seedling, six are Cox's Orange Pippin, and six Potts' Seedling—three varieties which show marked differences of habit. For the purposes of the present report it will be convenient to number these experiments 1 to 60, although on the ground (*see* plan) these numbers are applied to Bramley's seedling only, the other varieties being numbered 61 to 120, and 121 to 180, respectively. The distance allowed between the neighbouring trees is 3·34 m. (11 feet) in all cases, except in that of Bramley's Seedling, where it has been increased in one direction to 4·1 m. (13 ft. 6 in.), in order to suit the more vigorous habit of this variety. A few of the experiments are repeated with a fourth variety of apple—Stirling Castle, Nos. 181 to 188—which is a weaker grower than the other three. The distance between the neighbouring trees in this case is 1·82 m. (6 ft. 6 in.).

There are six experiments distributed at about equal intervals throughout the plot, in which the treatment of the trees is normal. These afford a means of estimating any effects caused by differences of soil or position in the ground.

Normal treatment consists of planting the trees in trenched ground in the autumn, cutting the branches back to about a third of their length before the following spring, applying the mixed mineral manure in the autumn and sodium nitrate in the spring, moderately pruning in autumn, and moderately shortening the growths in summer. All blossoms at the ends of shoots are removed, and the fruit is thinned in early summer so as to leave not more than two fruits on the same spur.

In the following list of experiments the treatment is normal, except as regards the particular point mentioned.

The actual space round the tree which was manured in 1895–6, the amount of manure then given, and the annual increment in the length and breadth of the space which will be manured in subsequent years, are as follows:—

——	Space.	Mixed Minerals.	Nitrate.	Annual Increment.
	m.	grms.	grms.	m.
Bramley's - -	0·91 × 0·76	21·6	7·5	0·32 and 0·26
Cox's and Potts' -	0·76 × 0·76	18·0	6·3	0·26 „ 0·26
Stirling Castle -	0·61 × 0·61	11·5	4·1	0·12 „ 0·12

With the standard apple trees mentioned below the dressings were—

Bramley's - -	0·91 × 0·91	25·8	9·0	0·31 and 0·31
Cox's - -	0·83 × 0·83	21·5	7·5	0·244 „ 0·244
Prince Albert -	0·76 × 0·76	18·3	6·3	0·14 „ 0·14

1 to 60.—Dwarf Apple Trees on the Paradise Stock.

Six of each of Bramley's Seedling, Cox's Orange Pippin, and Potts' Seedling in each Experiment.

Experiment.	Treatment.
	Branch Treatment.
1	Normal.
2	Not cut back till the end of the year after planting.
3	Cut back after planting, but not subsequently pruned nor shortened.
4	Not cut back, pruned nor shortened.

1 TO 60.—DWARF APPLE TREES ON THE PARADISE STOCK —*continued.*

Experiment.	Treatment.
	Branch Treatment—continued.
5	Autumn pruning only; no summer shortening.
6	Hard autumn pruning;* „ „
7	Summer pinching† and autumn pruning.
8	„ „ no autumn pruning.
9	Summer pruning proper; no autumn pruning.
10	Normal.
	Root Treatment.
11	Root pruned when necessary.
12	„ „ every fourth year.
13	„ „ „ second „
14	„ „ „ year.
15	Lifted every second year, but root injury avoided as far as possible.
	Treatment of Surface Soil.
16	Soil mulched with clean straw.
17	Grass grown round the trees; the mowings left on the ground.
18	Surface of ground beaten hard.
19‡	Weeds allowed to grow.
20	Ground dug two or three times a year close to roots, but without injuring them.
21	Normal.
	Different Manures.
22	No phosphate. Potash and calcium sulphate§ in autumn; nitrate in spring.

* In hard pruning, about three-quarters of the preceding season's growth was removed; in moderate pruning, about one-half.

† Pinching consists in removing the growths in early summer to the third leaf from the base of the shoot, any lateral growths which occur subsequently are pinched to the second leaf.

‡ Owing to an error, the weeds were removed in 1895, consequently the trees were taken up in November of that year and re-planted. They are comparable with those in No. 56, which were similarly re-planted.

§ Equivalent to that present in the superphosphate in the normal mixture, namely, 6·87 grams per square metre.

1 TO 60.—DWARF APPLE TREES ON THE PARADISE STOCK —*continued.*

Experiment.	Treatment.
	Different Manures—continued.
23	No potash. Phosphate and magnesium sulphate (as in the normal mixture) in autumn; nitrate in spring.
24	No nitrate. Normal mineral mixture in autumn.
25	Iron in summer.* Minerals and nitrate as in the normal plots.
26	Manganese in summer. Minerals and nitrate as in the normal plots.
27	Stable manure, 30 tons to the acre, dug in over whole of the ground before planting. Artificial manures as in the normal plots.
28	Stable manure (12 tons to the acre) applied round the trees every autumn. Artificial manures also.
29	Minerals as in normal plots in autumn; ammonium sulphate† in spring.
30	Ammonium sulphate in spring; minerals, but without the potash, in autumn.
31	Normal till 1896-7; afterwards stable manure (12 tons) only.
	Amount of Manure.
32	No manure.
33	Half the ordinary minerals and nitrate.
34	Normal.
35	Amount of minerals and nitrate to be increased up to a certain point, and then to be kept constant.
36	Amount of minerals and nitrate to be increased continuously.
	Time of Applying Manure.
37	Minerals in spring, nitrate in spring.
38	,, summer, ,,
39	,, autumn, ,, (normal).
40	,, ,, summer.
41	,, ,, autumn.

* 2·8 grams of crystallised iron sulphate per square metre.

† Equivalent to the nitrate in the normal plots, namely, 7·7 grams per square metre.

1 TO 60.—DWARF APPLE TREES ON THE PARADISE STOCK —*continued.*

Experiment.	Treatment.
	Planting, &c.
42*	Carelessly planted without trimming roots, but otherwise tended and manured.
43*	Carelessly planted, neglected, and not manured. After the first year the trees were tended and manured.
44*	Carelessly planted, neglected, and not manured.
45*	Planted in ground dug one spit only.
46	Planted in holes 3 ft. deep.
47	Planted in holes 2 ft. deep with chalk bottoms.
48	Planted about 4 inches too high.
49	,, 4 ,, low.
50	Chalk mixed with the soil in about equal bulks.
51	Flints ,, ,, ,,
52	Gravel ,, ,, ,,
53	Peat ,, ,, ,,
54	Thomas' slag in lumps about the size of hazel-nuts dug into the ground before planting, at the rate of two tons to the acre.
55	Planted in rich compost.
	Time of Planting, &c.
56†	Normal (planted in November).
57†	Planted in January.
58†	Planted in March.
59	All blossoms removed for several years.
60	Trees which had been damaged by hares, &c.

* In these experiments the ground was dug one spit deep, instead of being trenched. In 43 and 44, as in the other plots, the weeds were removed from the ground before planting the trees.

† The season 1894–5 did not allow of these plots being planted at the times selected, the trees were, therefore, taken up in the following season, kept in a shed for two days, and then re-planted.

181 to 188.—Dwarf Apple Trees on the Paradise Stock.

Six Stirling Castle in each Experiment.

Experiment.	Treatment.
181	Cut back when planted; not afterwards shortened nor pruned.
182	Root pruned every year.
183	Normal.
184	No nitrate. Normal mineral manure in autumn.
185	Amount of minerals and nitrate increased annually.
186	Minerals in autumn, nitrate in July.
187	Planted in rich compost.
188	All blossoms removed for the first few years.

189 to 225.—Standard Apple Trees on the Crab Stock.

189 to 199.—Bramley's Seedling.

200 to 211.—Potts' Seedling.

212 to 225.—Lane's Prince Albert.

Six trees of each variety in each Experiment.

Experiment.	Treatment.
189, 201 & 213	Grass grown round the trees.
190, 202 & 214	Autumn pruning only; no shortening.
191, 203 & 215	Normal.
192, 204 & 216	Summer shortening only; no pruning.
193, 205 & 217	No nitrate. Minerals in autumn.
194, 206 & 218	Summer pruning only.
195, 207 & 219	Amount of minerals and nitrate increased annually.
196, 208 & 220	Carelessly planted and neglected. No manure.
197, 209 & 221	Minerals in autumn; nitrate in July.
198, 210 & 222	Planted about 4 in. too low.
199, 211 & 223	Planted in holes 1½ ft. deep with chalk bottoms.
224	Properly planted, but weeds allowed to grow.
225	Blossoms removed for the first few years.

The distances between consecutive trees in each plot of the standards are, in the case of Bramley's, 9·1 m. (30 feet); in that of Potts', 6·7 m. (22 feet); and in that of Prince Albert, 4·6 m. (15 feet); but the distances between the trees in the consecutive experiments are only half of these quantities, since the alternate experiments, 190, 192, &c., are expected to be complete in a few years, after which the trees in them will be removed.

226 to 264.—Apple Trees Trained in different ways.

These trees were planted as maidens in 1894. An equal number of the three varieties—Bramley's, Cox's and Stirling Castle—constitute each experiment.

Experiment.	No. of Trees.	Treatment.
226, 7 & 8 -	6 trees each	Natural open bushes.
229, 30 & 31 -	6 ,, -	Bushes with leaders removed.
232, 3 & 4 -	6 ,, -	Trained in bowl-shape.
235, 6 & 7 -	6 ,, -	Trained pyramids.
238, 9 & 40 -	8 ,, -	Horizontal espaliers. Two of each variety pointing N. and S., two E. and W., two N.E. and S.W., and two N.W. and S.E.
241, 2 & 3 -	3 ,, -	Vertical espaliers.
244, 5 & 6 -	3 ,, -	Palmettes Verrier.
247, 8 & 9 -	12 ,, -	Single horizontal cordons.
250, 1 & 2 -	6 ,, -	Triple horizontal cordons.
253, 4 & 5 -	12 ,, -	Single vertical cordons.
256, 7 & 8 -	6 ,, -	Triple vertical cordons.
259, 60 & 61 -	12 ,, -	Single inclined cordons.
262, 3 & 4 -	6 ,, -	Triple inclined cordons.

265 to 379.—Collection of Apples on the Paradise and Crab Stocks.

An equal number of stocks of an English broad-leaved paradise and of crab were planted in 1894–5, together with one or two trees of each of the varieties of apples with which it was intended to bud or graft the stocks. The budding was performed in 1896, and where sufficient buds had not taken, grafting in the following season was resorted to.

It is intended eventually to have eight trees of each variety all grown as bushes, four on each of the two stocks; of these four, two will be subjected to hard pruning, and two to very little pruning. The eight trees will be alternated in the rows, so that the whole plot of varieties may be divided down the ground into two or four precisely similar sections, and on these the effect of different insecticides will be tried.

The varieties are arranged under the headings of "Dessert," "Dessert and Culinary" and "Culinary," and the varieties in each class are arranged roughly in their order of ripening. The culinary varieties occupy the lower portion of the ground.

The following are the varieties planted, the nomenclature adopted being the same as that in Dr. Hogg's "Fruit Manual":—

Dessert.

Early.

265	Mr. Gladstone.	273	Yellow Ingestrie.
266	Margaret (Red Juneating).	274	Duchess of Gloucester.
267	Beauty of Bath.	275	Worcester Pearmain.
268	Irish Peach.	276	Williams' Favourite.
269	Devonshire Quarrenden.	277	Early Peach.
270	Lady Sudeley.	278	Okera.
271	Red Astrachan.	279	September Beauty.
272	Kerry Pippin.		

DESSERT—*continued.*

Mid Season.

280 American Mother.
281 Margil.
282 Cockle's Pippin.
283 Cox's Orange Pippin.
284 Mabbott's Pearmain.
285 Braddick's Nonpareil.
286 Egremont Russet.
287 King of the Pippins.
288 Rosemary Russet.
289 Ross Nonpareil.
290 Mannington's Pearmain.
291 Brownlees' Russet.
292 Christmas Pearmain.
293 Ribston Pippin.
294 Roundway Magnum Bonum.
295 Claygate Pearmain.

Late.

296 Scarlet Pearmain.
297 Fearn's Pippin.
298 D'Arcy Spice.
299 Duke of Devonshire.
300 Allen's Everlasting.
301 Sturmer Pippin.
302 Armorel.
303 Court Pendû Plat.
303A Herefordshire Pearmain.

DESSERT AND CULINARY.

Early.

304 Cardinal.
305 Sugar Loaf.
306 Duchess of Oldenburg.
307 Gravenstein.
308 Cellini.
309 Golden Spire.

Mid Season.

310 Queen Carolina.
311 The Queen.
312 Beauty of Hants.
313 Wealthy.
314 Landsberger Reinette.
315 Cox's Pomona.
316 Mère de Ménage.
317 Peasgood's Nonesuch.
318 Lord Derby.
319 Gospatric.
320 Gascoygne's Seedling.
321 Baumann's Reinette.
322 Tom Putt.
323 Wadhurst Pippin.
324 Schoolmaster.

Late.

325 Sandringham.
326 Baxter's Pearmain.
327 Reinette de Canada.
328 Blenheim Orange Pippin.
329 Lane's Prince Albert.
330 Beauty of Kent.
331 Hambling's Seedling.
332 Hormead Pearmain.
333 Lady Henniker.
334 Grange's Pearmain.
335 Bramley's Seedling.
336 Belle de Pontoise.
337 Dutch Mignonne.
337A Lewis' Incomparable.

CULINARY.

Early.

338 White Transparent.
339 Early Julyan.
340 Keswick Codlin.
341 Early Rivers.
342 Lord Grosvenor.
343 Lord Suffield
344 Potts' Seedling.
345 Domino
346 Old Hawthornden.
347 Mank's Codlin.
348 Nonesuch.
349 Northern Dumpling.
350 Frogmore Prolific.
351 Grenadier.
352 Ecklinville.
353 Gold Medal.

Mid Season.

354 Stirling Castle.
355 Golden Noble.
356 Warner's King.
357 Tower of Glammis.
358 Loddington (Stone's Apple).
359 Hollandbury.
360 Maltster.
361 Royal Jubilee.
362 New Hawthornden.

Late.

363 Bismarck
364 Bedfordshire Foundling.
365 Twenty Ounce.
366 New Northern Greening.
367 Northern Greening.
368 Alfriston.
369 Gloria Mundi (Belle Dubois).
370 Newton Wonder.
371 Norfolk Beefing.
372 Annie Elizabeth.
373 Tyler's Kernel.
374 Dumelow's Seedling.
375 Chelmsford Wonder.
376 Flanders Pippin.
377 Byford Wonder.
378 High Canons.
379 Vicar of Beighton.

380 TO 459 AND 589 TO 594.—COLLECTION OF DIFFERENT VARIETIES OF STRAWBERRIES.

On the north-east border of the ground 13 plants of each of 86 varieties of strawberries have been planted. From these runners are taken, and fresh rows planted annually two feet from the previous ones, so that ultimately each variety will be represented by plants of five different ages. Data will thus be obtained for the comparison, not only of different varieties under similar treatment, but also of the same variety at different periods of its life.

London dung, at the rate of 30 tons to the acre, is supplied annually to the plants. No artificial manure is used.

The following is a list of the varieties planted:—

380 Laxton's No. 1.
381 King of the Earlies
382 John Ruskin.
383 Scarlet Queen.
384 Black Prince.
385 Noble.
386 Crescent Seedling.
387 Vicomtesse Héricart de Thury.
388 Keens' Seedling.
389 Competitor.
390 Sharpless
391 Captain.
392 Auguste Nicaise.
393 Royal Sovereign.
394 La Grosse Sucrée.
395 Sensation.
396 Pauline.
397 Edouard Lefort.
398 Alice Maud.
399 Teutonia.
400 Souvenir de Bossuet.
401 Sir Joseph Paxton.
402 White Knight.
403 Sir Harry.
404 James Veitch.
405 Marguerite.
406 Doctor Morere.
407 Cockscomb.
408 Preston Seedling.
409 Sir Charles Napier.
410 Bubach (American).
411 Austria.
412 Duke of Edinburgh, No. 1.*
413 Commander.
414 Bothwell Bank.
415 The Albert.
416 A. F. Barron.
417 La France.
418 Countess.
419 President.
420 Stirling Castle.
421 Lord Suffield.
422 Gunton Park.
423 Empress of India.
424 British Queen.
425 McMahon.
426 Lucas.
427 Empress Eugénie.
428 George Lesuir.
429 Aberdeen Favourite.
430 Duke of Edinburgh, No. 2.*
431 George Rundle.
432 Mrs. Laxton.
433 President Delacœur.
434 Amateur.
435 Enchantress.
436 Admiral Dundas.
437 Souvenir de Kieff.
438 La Constante.
439 Helena Glœde.
440 Kitley's Goliath.
441 Pioneer.
442 Unser Fritz.
443 Lord Napier.
444 Jubilee.
445 Doctor Hogg.
446 Latest of All.
447 Eleanor.
448 Filbert Pine.
449 Loxford Hall Seedling.
450 Old Pine, or Carolina.
451 Frogmore Late Pine.
452 Elton Pine.
453 Waterloo.
454 Myatt's Prolific.
455 Boothby's Sweetheart.
456 Premier.
457 Garten Direcktor O. Hüttig.
458 Andrew Desportes.
459 Red Alpine.
589 Bicton Pine
590 Leader.
591 Monarch.
592 Comte de Paris.
593 Stevens' Wonder.
594 Royal Hautbois.

* The two varieties of Duke of Edinburgh were received as "Dr. Roden" and "Scotch," respectively, but doubts are entertained as to the correctness of these descriptions.

460 to 465.—Demonstration Plots.

Three half-acre plots are devoted to demonstrating how ground may be advantageously cropped with fruit by farmers, growers for market, and cottagers, respectively. Each plot is divided into two equal parts (A and B), in which slightly different methods of planting have been adopted, and in every case records of the market value of the produce will be kept.

These plots have also been utilised for certain experimental purposes, which are not expected to materially affect the returns.

460 and 461.—Farmers' Plots A and B.

In these plots standard apple trees of free growing varieties are planted 9 m. (30 feet) apart; between these are planted dwarf apples, pears and plums at distances of 4·5 m. (15 feet), and between these there are gooseberries and currants at distances of 1·5 m. (5 feet). These distances will render thinning unnecessary for some years.

Plot A differs from plot B in having the alternate rows of dwarf trees and bushes omitted, so that roots or similar crops may be grown between the remaining rows. The dwarf trees and bushes will be ultimately removed, and the ground under the remaining standards laid down to grass.

The following is a list of the varieties of apples, pears and plums planted in these plots, and Figs. 1 and 2 show the arrangement of the trees, these being indicated

by different letters, and the bush fruit indicated by dots.

460.

Standard Apples, A.	*Bush Pears*, *p*.
Yellow Ingestrie.	Pitmaston Duchess.
Warner's King.	Beurré Hardy.
Newton Wonder.	Williams' Bon Chrêtien.
Bush Apples, *a*.	*Plums*, *π*.
Potts' Seedling.	Rivers' Early Prolific.
Lord Grosvenor.	Victoria.
Bramley's Seedling.	Early Transparent Gage.
Cox's Pomona.	Monarch.

Bush fruits marked .

461.

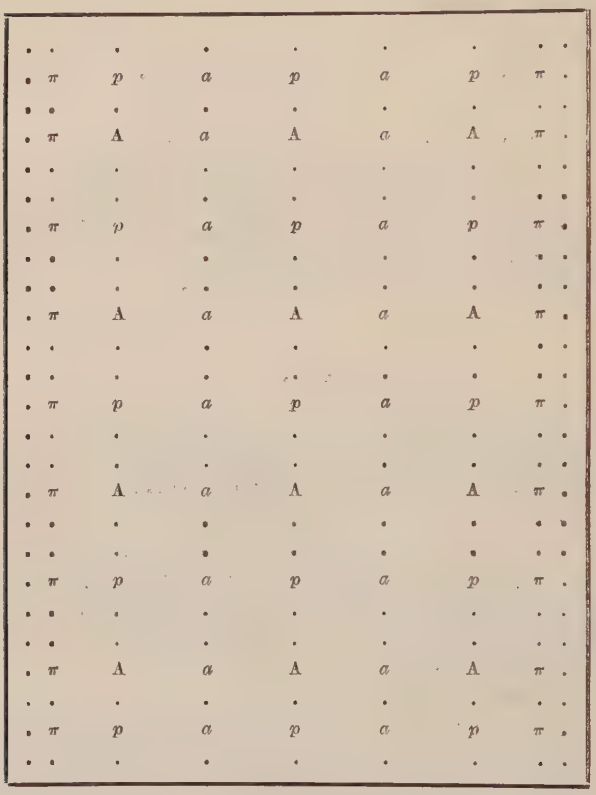
Standard Apples, A.	*Bush Pears*, *p*.
New Northern Greening.	Beurré Giffard.
Golden Noble.	Madame Treyve.
Bismarck.	Durondeau.
Bush Apples, *a*.	*Plums*, *π*.
Worcester Pearmain.	New Early Orleans.
Duchess of Oldenburg.	Denniston's Superb.
King of the Pippins.	Prince Englebert.
Peasgood's Nonesuch.	
Gascoygne's Scarlet Seedling.	
White Transparent.	

Bush fruits marked .

In the upper half of plot 460 London manure, at the rate of 30 tons to the acre, was dug into the ground in 1894 before the trees were planted. To the lower half the same amount is being applied, but in annual doses of 10 tons to the acre: the first of these was applied in 1895, so that by the end of 1897 each half will have received the same amount of manure, but in

FIG. 1.—FARMERS' DEMONSTRATION PLOT A, No. 460.

Scale, 30 Feet to the Inch.

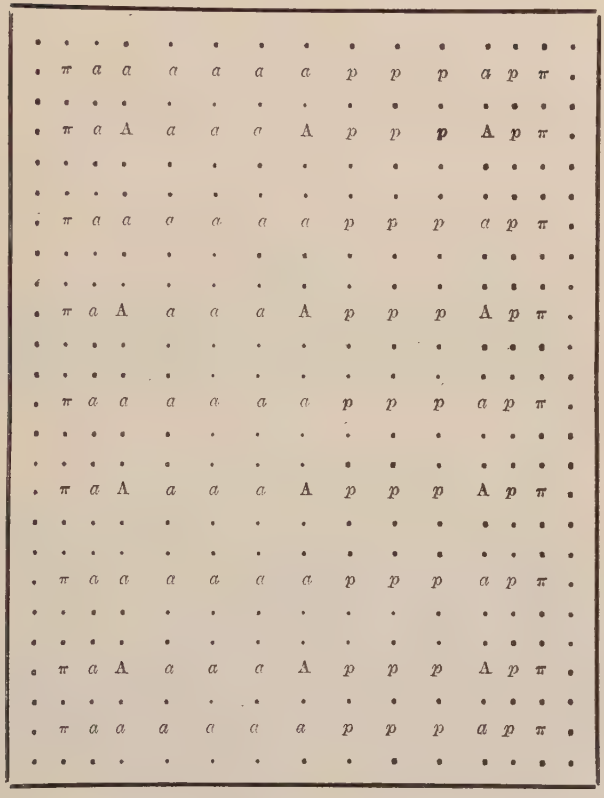


different ways. These dressings refer to the strips occupied by the trees; the spaces between them, where roots, &c., are grown, are dunged independently for each crop. The trees have also been dressed with artificial manure.

In plot 461 trees of the same varieties and on the same stock, but of different ages, have been planted, in

FIG. 2.—FARMERS' DEMONSTRATION PLOT B, No. 461.

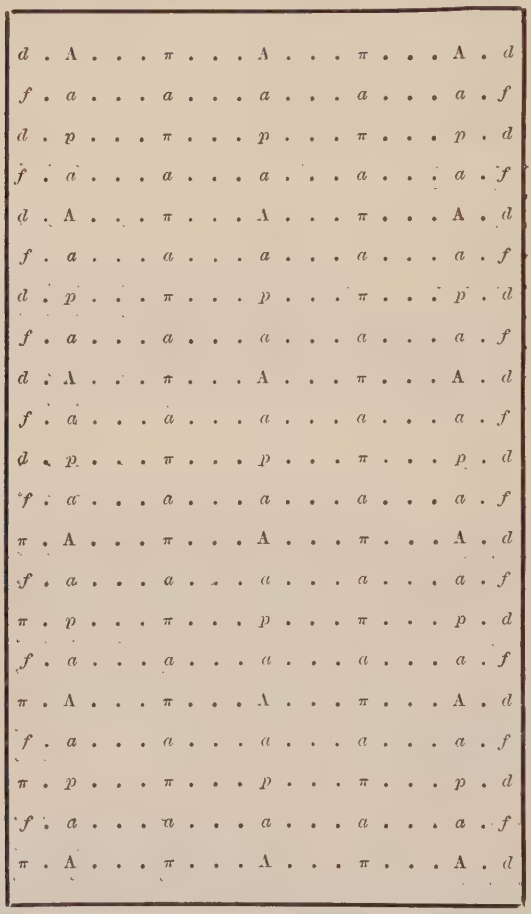
Scale, 30 *Feet to the Inch.*



order to ascertain the age at which trees may be most profitably transplanted. There are three trees of each of three varieties of half-standard plums, and also of standard apples, two and four years old in each case, and of both dwarf apples and dwarf pears a similar number of trees and of varieties at the four ages—one to four years—have been planted.

FIG. 3.—GROWERS' DEMONSTRATION PLOT A, No. 462.

Scale, 30 Feet to the Inch.

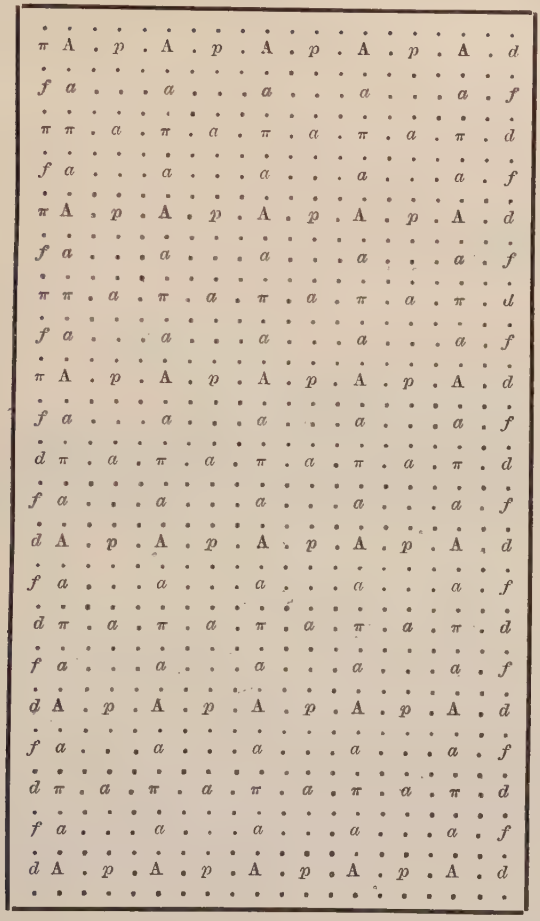


462 AND 463.—GROWERS' PLOTS A AND B.

In these plots the ground is planted closely for immediate returns, and the trees are arranged so that they may easily be thinned when they become too close.

Plot A differs from plot B in having fewer dwarf trees and bushes, and in having strawberries and raspberries in their place. The varieties of apples and

FIG. 4.—GROWERS' DEMONSTRATION PLOT B, No. 463.
Scale, 30 *Feet to the Inch.*



pears, especially the standard apples, are smaller growers than in the farmers' plots, and, consequently, less space has been allowed to them. The arrangement in the two plots is different: the distances between neighbouring standard trees vary from 8·2 to 4·9 m. (27 to 16 feet), and that between the bushes from 1·2 m. to a little over 1 m. (3 ft. 4 in.).

The details of the arrangement are given in Figs. 3 and 4, and in the following list:—

462.

Standard Apples, A.

Grenadier.
Domino.
Worcester Pearmain.
Cox's Orange Pippin.
Ecklinville.
Cox's Pomona.

Bush Apples, *a*.

Bismarck.
Gold Medal.
Bramley's Seedling.
Baumann's Reinette.
Gascoygne's Scarlet Seedling.

Bush Pears, *p*.

Clapp's Favourite.
Fertility.
Pitmaston Duchess.

Plums, *π*.

New Early Orleans.
The Czar.
Monarch.
Poupart's.
Rivers' Early Prolific.

Damsons, *d*.

Crittenden.
Bradley's King.
Prune.

Nuts, *f*.

Kentish Cob.
Pearson's Prolific Filbert.

Bush fruits marked .

463.

Standard Apples, A.

Lord Grosvenor.
Worcester Pearmain.
Cox's Pomona.
Potts' Seedling.
Cox's Orange Pippin.
King of the Pippins.

Bush Apples, *a*.

White Transparent.
Stirling Castle.
Gascoygne's Scarlet Seedling.
Domino.
Lady Sudeley.
Bismarck.
Royal Jubilee.
King of the Pippins.
Lane's Prince Albert.

Bush Pears, *p*.

Dr. Jules Guyot.
Beurré d'Amanlis.
Doyenné du Comice.
Emile d'Heyst.

Plums, *π*.

Rivers' Early Prolific.
Sultan.
The Czar.
Sandall's.
Monarch.
Diamond.

Damsons, *d*.

Crittenden.
Bradley's King.
Prune.

Nuts, *f*.

Webb's Prize Cob.
Merveille de Bollwyller.

Bush fruits marked .

In these two plots an attempt has been made to ascertain the effects of cutting back and pruning the trees and bushes at different times and to different extents.

In the upper third of plot 462 all the trees and bushes are hard pruned; in the middle third the pruning is moderate, and in the lower third it is very slight. Similarly, in the upper third of plot 463 the trees and bushes were cut back originally, and are now pruned, in autumn: in the middle third this was, and is, done in winter, and in the lower third, in spring.

464 and 465.—Cottagers' Plots A and B.

In these two plots the character of the trees is similar to those in the growers' plot, but more space has been allowed to them, and half the ground in each plot is devoted to vegetables. In plot A the fruit and vegetables are grown on separate halves of the ground, whereas in B the vegetables are grown between the rows of trees. The trees and bushes are identical as to variety and number in the two plots.

A portion of the trees in plot B were banked up temporarily with earth after planting. This is a convenient method of keeping the trees steady without using stakes, and is held to be a protection from frost. No difference, however, has been noticed between the trees which were thus treated and those which were not, in spite of the severity of the winter succeeding the planting.

The upper half of that portion of plot 404 which is occupied by trees had, like a portion of the farmers' plots, dung dug into the ground before planting, while the lower half is receiving the same amount in three annual top dressings.

The following gives a summary of number of trees and bushes per acre required on the systems of planting

adopted in these demonstration plots. In the case of the farmers' plot A, and both the cottagers' plots, it must be remembered, only half the ground is occupied by the fruit trees, the other half being used for vegetables.

Fruit.	Farmers.		Growers.		Cottagers.	
	A.	B.	A.	B.	A.	B.
Standard apples - -	48	48	72	120	32	32
Dwarf apples - - -	72	204	200	280	152	152
Dwarf pears - - -	60	144	60	80	32	32
Plums and damsons - -	72	72	176	188	72	72
Nuts - - - -	—	—	80	80	—	—
Total - - -	252	468	588	748	288	288
Currants and gooseberries -	648	1,032	1,176	3,136	912	912
Raspberries - - -	—	-	792	—	408	408
Strawberries - - -	—	—	6,224	—	—	—

The cost per acre of preparing and planting the ground has been—

	Farmers.		Growers.		Cottagers.
	A.	B.	A.	B.	
	£	£	£	£	£
Trenching and forking - -	21*	21	21	21	21
Planting and staking - -	2	3	6	6	4
Cost of trees and bushes - -	24	36	68	76	40
Total - - -	47	60	95	103	65

* If the spaces between the rows of trees were not trenched, the cost of this item would be reduced to 10*l*. 10*s*.

It may be mentioned, however, that the cost of preparing lighter soil, or cleaner ground, would be considerably less than the above, and that a further reduction in this item would be effected in cases where plough-cultivation could be adopted. In large quantities, also, the trees and bushes could be obtained at reduced rates, and the cost might be still more reduced by planting younger stock, though in this latter case the reduction would be effected only at the expense of time before bearing commenced.

466 to 471.—Experiments on the Arrangement of Trees.

Three plantations of bush plum trees have been formed, with the object of ascertaining the respective merits of the different systems in which the same number of trees may be arranged in a given space.

Each plantation consists of 36 trees—12 Monarch, 12 Czar and 12 Victoria—surrounded by trees of Rivers' Early Prolific, so that none of the experimental trees are "outside" trees on their respective plantations.

Each plantation represents an arrangement giving 1,210 trees to the acre, and, therefore, every tree has the same amount of space allotted to it.

No. 466 represents the square system of arrangement. The neighbouring trees are 1·83 m. (6 ft.) apart in two directions at right angles to each other.

No. 467 represents a rectangular system of arrangement, in which the distances between the trees in one direction·—2·59 m. (8 ft. 6 ins.)—are double those—

1·30 m. (4 ft. 3 ins.)—between them in a rectangular direction.

No. 468 represents an hexagonal, or equilateral triangular arrangement, in which the trees form rows inclined to each other at angles of 60°, instead of 90°, as in the preceding arrangements. The distance between the trees in these rows is 1·99 m. (6 ft. 6½ ins.).

In Nos. 469 to 471 an attempt is being made to determine the merits of different arrangements as regards the effect of the amount of light and air received by the trees, eliminating such effects as are due to the interference of the roots. This has been done by planting the trees sufficiently far apart to avoid any such interference, and placing screens round the trees in positions such that they represent neighbouring trees on the different systems of arrangement.

The screens are altered in size every year, so as to be equal in area to the average section of the trees before they start into growth. In the square arrangement they are placed at a distance equal to half of the height of the tree, and in the hexagonal arrangement at 1·09 times that distance, just as trees would be if there were the same number to the acre in the two arrangements.

Such proximity is, of course, greater than would exist in any proper plantation; but it is our object to exaggerate the effects of crowding, so as to obtain more quickly results which will settle the respective merits of the different arrangements.

The effect of the different directions in which the rows of trees are planted on the square system is being investigated in plots 469 and 470, in the former of which the screens are placed north-east and south-west of the trees, and in the latter towards the intermediate points of the compass.

472 to 495.—Hedges.

The various hedges which have been planted for protective purposes in the ground consist of fruit trees of different descriptions. The varieties planted, either alone or in combination, are as follows:—

Crab Apples—
- American.
- Dartmouth.
- Siberian, red.
- Siberian, yellow.
- John Downie.
- Fairy.
- Transcendent.
- Transparent.
- Orange.

Plums—
- Early Prolific.
- Cherry (Myrobalan).
- Mirabelle petite.
- Victoria.
- Czar.

Damsons—
- Crittenden.
- Prune.
- White.
- Shropshire.

Bullace—
- Shepherd's white.

Nuts—
- Pearson's Prolific Filbert.
- Cosford Filbert.
- White Prolific Filbert.
- Kentish Cob.

Quince—
- Pear-shaped.
- Angers.

Medlars—
- Royal.
- Dutch.
- Nottingham.

Berberis—
- vulgaris.
- „ asperma.

501 to 506.—Experiments on Dressing Strawberries during the Fruiting Season.

These plots occupy the spaces between the Bramley's standard apples, the first plot (501) occupying the two half-spaces on the outside of the trees. The strawberries were planted in 1895. Each plot contains 528 plants, these plants being of the same varieties in every case—24 plants of each of 21 varieties, and six plants of each of another four varieties. The plants are planted at a distance of two feet from their neighbours, and each plot occupies 0·0485 of an acre. The various dressings are applied in four equal doses once a week during the swelling of the fruit, the dressings being dissolved in

water in such quantity that each plant receives about one litre (one quart) of water at each application. The total quantity of the manures thus applied is equivalent to one and a quarter times that used in the experimental apple plots, and may be taken as roughly equivalent to an application of 15 tons of dung to the acre, so far as the particular constituent in question is concerned.

The dressings given to the plots are—

Experiment.	Treatment.
501	None.
502	Water only.
503	Water and 1,800 grams (3·96 lbs.) of ammonium sulphate (in the four dressings together).
504	Water and 2,660 grams (5·87 lbs.) of sodium nitrate.
505	,, 3,170 ,, (6·98 lbs.) of potassium nitrate.
506	,, 1,800 ,, (3·96 lbs.) of ammonium sulphate with 733 grams (1·65 lbs.) of iron sulphate.

The dressings, it will be seen, are designed to determine the influence of nitrogen, potash, soda and iron on the crop.

The varieties planted are as follows, those marked † being the ones of which there are only six plants in each plot :—

1 = Early. 2 = Mid Season. 3 = Late.
A = Small. B = Medium C = Large.

1 A { Laxton's No. 1. / Crescent Seedling.
1 B { Pioneer. / Scarlet Queen.
1 C { Noble. / Auguste Nicaise.

2 A { Edouard Lefort. / The Albert.
2 B { La Constante. / Empress of India.
2 C { Sensation. / Kitley's Goliath.

3 A { Mrs. Laxton. / Loxford Hall.
3 B { Dr. Hogg. / Enchantress.
3 C { Latest of All. / Waterloo.

† Leader.
† Monarch.
† Stevens' Wonder.
† Hautbois.
Old Pine.
Elton Pine.
La France.

507 TO 512.—GOOSEBERRIES.

A collection of gooseberries is planted between the rows of standard Cox's Orange Pippins, in the same way as are the strawberries described above. They form six plots, each of which contains 24 plants of all the varieties, and these plots are being treated differently as to the manure which is applied to them, with a view to ascertain the relative value of artificial and stable manure, and also the value of different quantities of these dressings.

Experiment.	Treatment.
507	Received no manure.
508	,, stable manure; 12 tons to the acre in autumn.
509	,, ,, ,, 30 ,, ,,
510	Received mineral manure in autumn, 28·8 grams per square metre; nitrate, 10·0 grams per square metre in spring.*
511	Received mineral manure in autumn, 72 grams per square metre; nitrate, 25·0 grams per square metre in spring.
512	Received mineral manure in autumn, 36 grams per square metre; and in spring, mineral manure, 36 grams, and nitrate, 25·0 grams.

The bushes were for the most part three years old when planted in 1895–6, and three feet has been allowed between the neighbouring plants.

The varieties are—

Useful on account of Earliness.

Red.—Companion.	Green.—Lofty.
Magnet.	Green Gascoigne.
Keen's Seedling.	Green Walnut.
Yellow.—Early Sulphur.	White.—Alice.
Australia.	Cheshire Lass.
Leader.	Lady Leicester.

* The same as the dressing applied to the apple plots, being roughly 2½ cwt. of minerals and 1 cwt. of nitrate to the acre.

Useful on account of Flavour.

Red.—Red Champagne.
Red Warrington.
Rough Red.

Green.—Green Overall.
Pitmaston Greengage.
Hebburn's Prolific.

Yellow.—Yellow Ball.
High Sheriff.
Yellow Champagne.

White.—Whitesmith.
Eagle.
Bright Venus.

Useful on account of Size.

Red.—Conquering Hero.
London.
Dan's Mistake.

Yellow.—Leveller.
Mount Pleasant.
California.

Green.—Matchless.
Beeston Castle.
Thumper.

White.—Antagonist.
Freedom.
Howard's Lancer.

Useful on account of Free Bearing.

Crown Bob.
Whinham's Industry.
Lancashire Lad.
Queen of Trumps.
Rumbullion.
Keepsake.
Roseberry.
Legerdemain.

514 to 519.—Currants and Raspberries.

The spaces between the Lane's Prince Albert standards are utilised in a similar way for six plots, which each contain 12 plants of the following currants and raspberries.

These plots are also treated with different dressings, precisely similar to those used for the gooseberry plots 507 to 512.

Black Currants—
Baldwin's.
Black Naples.
Lee's Prolific.
Ogden's Black.

Red Currants—
Cherry.
Knight's Large Red.
Long-bunched Red.

Red Currants—*cont.*
Raby Castle.
Reine Victoria.
Red Champagne.
Red Dutch.

White Currants—
White Dutch.
Wilmot's White Dutch.
White Transparent.

Summer Raspberries—
Superlative.
Hornet.
Baumforths.
Carter's Prolific.
Norwich Wonder.
Falstaff.
Lord Beaconsfield.
McLaren's Prolific.
Northumberland Fillbasket.

Summer Raspberries—*cont.*
Red Antwerp.
Semper Fidelis.
White Magnum Bonum.

Autumn Raspberries—
Belle de Fontenay.
October Yellow.
Merveille de Quatres Saisons Jaune.

521 to 588.—Collection of Pears.

The collection of pear trees consist of bush trees which were three years old when planted in 1895–6. There are three of each variety on the pear stock, and three on the quince. As it is anticipated that our clay subsoil will necessitate frequent lifting of these trees, and we have, consequently, planted additional plots of three varieties—Beurré Giffard, Beurré d'Amanlis, and Beurré Hardy—which will not be lifted, and which, therefore, will show the effect of the omission of this operation.

The trees are planted at a distance of 3·66 m. (12 ft.) from their neighbours, but in many cases maidens of the same varieties as the three-year trees next above them, and on the same stocks, have been planted between the rows. These will be removed in a few years' time. Where such maidens have been planted an M is placed after the name of the variety in the following list:—

521 Doyenné d'Été.
522 Beurré Giffard.
523 Beurré Giffard.
524 Jargonelle. M.
525 Clapp's Favourite. M.
526 Williams' Bon Chrêtien. M.
527 Fertility.
528 Colmar d'Été.
529 Marguerite Marillat.
530 Beurré d'Amanlis.
531 Beurré d'Amanlis. M.
532 Madame Treyve.
533 Summer Beurré d'Aremberg. M.
534 President d'Osmonville.
535 Dr. Jules Guyot.
536 Beurré Superfin. M.
537 Fondante d'Automne.
538 Conference.
539 Beurré Hardy.
540 Beurré Hardy. M.
541 Jersey Gratioli. M.

542 Louise Bonne of Jersey. M.
543 Marie Louise d'Uccle. M.
544 Beurré Capiaumont.
545 Comte de Lamy.
546 Baronne de Mello.
547 Doyenné Boussoch.
548 Beurré Diel. M.
549 Magnet.
550 Doyenné du Comice. M.
551 Gansel's Bergamot.
552 Maréchal de Cour. M.
553 Durondeau. M.
554 Beurré Mortillet. M.
555 Pitmaston Duchess.
556 Aston Town.
557 Emile d'Heyst. M.
558 Beurré Bachelier.
559 Soldat Laboureur (Soldat Esperen).
560 Duchesse d'Angoulême.
561 Thompson's. M.
562 Marie Benoist. M.
563 Passe Colmar. M.
564 Hacon's Incomparable.
565 Winter Nelis.
566 Glou Morçeau. M.
567 Princess.
568 Zéphirin Grégoire.
569 Vicar of Winkfield.
570 General Todleben.
571 Verulam.
572 Catillac.
573 Beurré Sterckman.
574 Joséphine de Malines. M.
575 Bergamotte Esperen. M.
576 Easter Beurré. M.
577 Olivier de Serres.
578 Triomphe de Vienne. M.

In the following varieties those on the quince are double grafted, the intermediate stock being mentioned in brackets when known:—

579 Beacon (Marie Louise d'Uccle).
580 Souvenir du Congrès (Marie Louise d'Uccle).
581 Marie Louise (Marie Louise d'Uccle).
582 Thompson's
583 Beurré Bosc.
584 Hacon's Incomparable.
585 Beurré Clairgeau. M.
586 Zéphirin Grégoire.
587 Beurré Rance (Bergamotte Esperen).
588 Joséphine de Malines (Beurré Sterckman).

589 TO 594.—STRAWBERRIES, *see* p. 23.

595 TO 620.—COLLECTION OF PLUMS.

Twenty-six varieties of plums have been selected for this collection; of each of these there will be three bushes on each of six different stocks, and two standards on each of three different stocks. At present the collection has not got beyond the stage of the budding of the various stocks.

The stocks for the bush trees are—

Muscle.	Cherry plum.
Brompton.	St. Julien.
Damson.	Brussells.

And for the standards—

Damson, Brompton. Muscle.

The varieties of plums are—

595	The Czar.	608	Early Prolific.
596	Oullin's Golden Gage.	609	Victoria.
597	Denniston's Superb.	610	Sultan.
598	Greengage.	611	Prince of Wales.
599	Bryanston Gage.	612	Early Orleans.
600	Jefferson.	613	Red Magnum Bonum.
601	Rivers' Early Transparent.	614	White Magnum Bonum.
602	Monarch.	615	Prince Englebert.
603	Coe's Golden Drop.	616	Pershore.
604	Ickworth Impératrice.	617	Pond's Seedling.
605	Late Rivers'.	618	Diamond.
606	Sandall's.	619	Gisborne's.
607	Poupart's.	620	Belle de Septembre.

621.—Cherries.

We do not anticipate that our soil will prove suitable for cherry trees, and have, therefore, planted only 12 varieties, one bush and one standard in each case. The varieties are :—

1	Early Rivers'.	7	Elton.
2	Black Tartarian.	8	May Duke.
3	Bigarreau Napoléon.	9	Morello.
4	Governor Wood.	10	Kentish.
5	Black Eagle.	11	Flemish Red.
6	Bigarreau.	12	Wye Morello.

622.—Perry Pears.

The following perry pears have been planted :—

1	Butt.	7	Arlingham Squash.
2	Barland.	8	Rock Pear.
3	Moorcroft.	9	Pine Pear.
4	Oldfield.	10	Cheatboy.
5	Red Pear.	11	Taynton Squash.
6	Newbridge.		

623.—Cider Apples.

The cider apples consist of—

1 Bedan des Parts.
2 Cherry Pearmain.
3 De Boutteville.
4 Argille Grise.
5 Red Hereford.
6 Medaille d'Or.
7 Rouge Bruyère.
8 Cider Lady's Finger.
9 Green Styre.
10 Cowarne Red.
11 Dymock Red.
12 Sack Apple.
13 Joeby Crab.
14 Spreading Redstreak.
15 Kingston Black.
16 Eggleton Styre.
17 Foxwhelp.
18 Pym Square.
19 Black Hereford.
20 Coccagee.
21 White Must.
22 Brian Rose.
23 Skyrmes Kernel.

624.—Local Apples.

Bordering the road on the north-west of the ground there is a collection of apples of local origin other than English.

Scotch.

1 Oslin.
2 Summer Thorle.
3 Ravelston Pippin.
4 White Melrose.
5 Cambusnethan Pippin.
6 Scarlet Golden Pippin.
7 Sir W. Blackett.
8 Forfar Pippin.
9 Gogar Pippin.
10 Carlisle Codlin.
11 East Lothian Pippin.
12 Scotch Bridget.
13 Aitken's Seedling.
14 Dutch Fulwood.
15 Tam Montgomery.
16 Luffness Matchless.
17 Seaton House.
18 Galloway Pippin.
19 Macdonald's Seedling.
20 Edinburgh Castle.
21 Malcolm Dunn.
22 Ochiltree.
23 Cardross Green.
24 Allanbank.
25 James Welsh.
26 Lass o'Gowrie.
27 Baillie Neilson.
28 Dalziel Manse Codlin.
29 Maggie Grieve.
30 Jenny Sinclair.
31 Colston Strawberry.
32 James Grieve.
33 Beauty of Moray.
34 Northern Dumpling.
35 Winter Strawberry.

IRISH.

36	Lamas.	41	Victoria.
37	Dickson's No. 1.	42	Kerry Pippin.
38	Logan's Seedling.	43	Scarlet Crofton.
39	Caughley's Seedling.	44	Sam Young.
40	Stripey.		

FRENCH.

45	Reinette de Versailles.	50	Pomme Gris.
46	Calville blanche d'Été.	51	Duc d'Aumale.
47	Grosse St. Clements.	52	Calville Rouge Prècoce.
48	Reinette de Bordeaux.	53	Pigeonnette.
49	Reinette Van Mons.	54	Jacques Lebel.

GERMAN.

55	Werner's Goldene Reinette.	57	Segende Reinette.
56	Borsdorffer.		

ITALIAN.

58 Mela Carla.

RUSSIAN, &c.

59	Boicken.	63	Tetofsky.
60	Grand Sultan.	64	White Transparent.
61	Rinakowsky.	65	Red Sabluck.
62	Winintza Rambour.	66	Seriuka.

625.—ITALIAN PEARS.

The following pears of Italian origin are planted at the base of the Bramley standard plot. The Italian cherry, Morcadella, is also planted with them :—

1	Grosso Mazzacavallo	on quince.
2	Commendatore Betti	,,
3	Spadona	,,
4	Angelica Cedro	,,
5	Colmar Giuntini	,,
6	Campana	,,
7	Buziarda	,,
8	Beurré del Giusti	,,
9	Sardona	on pear.
10	Spina	,,

626 to 635.—Trees for Experiments on Cutting Back on Planting.

These ten plots consist of standard plums and apples, and dwarf pears and apples, there being six trees in each plot. In one plot the trees were cut back on planting, while in a second precisely similar plot the trees were not cut back till a year after planting. They form repetition experiments on a subject already investigated in the experiments with bush apple trees (Nos. 1 to 3), and there are also further repetitions with standard apples and plums numbered 668 to 671.

636 to 641.—Sheltering of Blossoms.

Three plots, each containing six bush Stirling Castle apples, have been planted in the lowest part of the ground: one plot will remain unsheltered during the blossoming season, another will be sheltered by screens above it, and the third by screens at the side towards the prevailing wind. Similar plots have also been planted in the highest portion of the ground.

642 to 649.—Different Methods of Pruning.

The six trees (dwarf Bramley's Seedling Apple on paradise stock) in each of these plots are pruned in a different manner as regards the nature of the cut made.

Experiment.	Treatment.
642	*Very slanting upward* cut with knife to outside bud.
643	Normal. Slightly *slanting upward* cut with knife to outside bud.
644	*Level* cut with knife to outside bud.
645	*Downward* slanting cut with knife to outside bud.
646	Level cut with knife 2 c.m. (1 inch) *above the bud.*
647	Normal cut with *sécateurs.*
648	Normal cut with knife to *inside bud.*
649	*Not pruned* at all.

650 and 651.—Effect of Bad Planting.

These consist of two plots of dwarf Bramley's Seedling and Cox's Orange Pippin (six trees of each), in which the effect of careless planting is investigated. They are repetitions of No. 42.

652 to 661.—Cross Fertilisation of Apples.

These plots have been planted with a view to a systematic investigation of cross fertilisation. Each plot consists of four trees showing marked differences in a certain particular property, and every two of these will be crossed with each other, so as to determine in what manner the properties are reproduced or blended in the offspring. The four parent trees are planted at the corners of plots of ground 13 m. (42½ ft. square). The results of each cross fertilisation will, after the seeds have germinated, and the seedlings have been grafted on to stocks, be planted in rows between the parents. Each pair of trees will give two series of crosses, in which the different trees are used as male or female respectively, and, therefore, there will eventually be six double lines of trees resulting from the crossing. The four vacant spaces in the figure thus formed will be occupied by seedlings from the self-fertilisation of each of the four parent trees.

The following are the groups which have been planted:—

652 Colour
1 Devonshire Quarrenden. (Red.)
2 Golden Noble. (Yellow.)
3 London Pippin. (Green.)
4 White Transparent. (White.)

653	Colour - - -	1	Mère de Ménage. (Red.)	
		2	Lord Grosvenor. (Yellow.)	
		3	Catshead. (Green.)	
		4	Calville blanche d'Été. (White.)	
654	Size of Fruit -	1	Blenheim Orange.	(Large.)
		2	Warner's King.	
		3	Keddlestone Pippin.	(Small.)
		4	Keswick Codlin.	
655	Season - - -	1	Devonshire Quarrenden.	(Early.)
		2	Lord Grosvenor.	
		3	Sturmer Pippin.	(Late.)
		4	Newton Wonder.	
656	Flavour - -	1	WorcesterPearmain.	(High flavour.)
		2	Maltster.	
		3	Dumelow's Seedling.	(Insipid.)
		4	Newton Wonder.	
657	Flavour - -	1	Ribston Pippin.	(High flavour.)
		2	Cornish Aromatic.	
		3	Colonel Vaughan.	(Insipid.)
		4	Benoni.	
658	Habit - -	1	Blenheim Orange.	(Free growing.)
		2	Warner's King.	
		3	Margil.	(Dwarf.)
		4	Lane's Prince Albert.	
659	Nature of Stocks -	1	Cox's Orange Pippin	(Paradise.)
		2	Newton Wonder	
		3	Cox's Orange Pippin	(Crab.)
		4	Newton Wonder	
660	Size of Flowers -	1	Cox's Orange Pippin	(Large.)
		2	Lord Derby	
		3	Ingestrie	(Small.)
		4	Bedfordshire Foundling.	
661	Time of Flowering -	1	Irish Peach.	(Early.)
		2	Keswick Codlin.	
		3	Court Pendû Plat.	(Late.)
		4	Ecklinville.	

662.—Collection of various "Berries."

The following different varieties of "berries" form a small collection between the plots of pear trees and the brook :—

Popular Name.	Botanical Name.	Natural Order.
Schaeffer's Black Colossal Raspberry	Rubus - -	Rosaceæ.
Newman's Thornless (Blackham Mammoth).	Rubus - -	Rosaceæ.
Wilson Junior - -	Rubus - -	Rosaceæ.
The Lawton - -	Rubus - -	Rosaceæ.
Logan Berry* - -	Rubus - -	Rosaceæ.
Cut-leaved - -	Rubus laciniatus -	Rosaceæ.
Common Bramble - -	Rubus fruticosus -	Rosaceæ.
Bilberry (Whortleberry) -	Vaccinium Myrtillus -	Vacciniaceæ.
Cowberry - -	Vaccinium Vitis-idæa -	Vacciniaceæ.
Cranberry - - -	Oxycoccus palustris -	Vacciniaceæ.
Crowberry - -	Empetrum nigrum -	Empetraceæ.

Collection of Trees and Shrubs.

In the strip of land beyond the brook a collection of trees and shrubs has been formed, including members of the orders of which our more important fruit trees are representatives.

Starting at the south-east extremity of the ground, the trees have been planted in the following order :—

Populus.
Ulmus.
Fraxinus.

* A cross between the raspberry and blackberry ; of American origin.

Prunus, Pyrus } with { Weigela. Berberis.
Lilacs.
Acer.
Sambucus.
Salix.
Quercus.
Juglans, Carya, Liquidambar } with { Ribes. Forsythia. Philadelphus.
Cratægus.
Viburnum.
Quercus with Rubus.
Laburnum.
Spiræa.
Ulmus.
Fraxinus.
Fagus.
Tilia.

Of the two important genera, Prunus and Pyrus, some of the more distinct types have been collected, and the following forms have been planted in the order named under the different sections:—

PRUNUS.

Section 1.—*Amygdalus.*

Prunus Amygdalus.
,, ,, var. flore pleno.
,, ,, ,, macrocarpa.
,, ,, ,, pendula.
,, ,, ,, Monstrueuse.
,, ,, ,, Hatch.
,, ,, ,, Pistache.
,, ,, ,, Princess.
,, ,, ,, Thin-shelled.
,, ,, ,, nana.
,, Persica.
,, ,, var. flore pleno albo.
,, ,, ,, flore pleno roseo.
,, ,, ,, dianthiflora.
,, ,, ,, foliis rubris.

Section 2.—*Armeniaca.*

Prunus triloba.

Section 3.—*Prunus.*

Prunus communis.
,, cerasifera.
,, ,, var. atropurpurea.
,, spinosa.
,, ,, var. flore pleno.
,, insititia.

Section 4.—*Cerasus.*

Prunus Avium.
,, ,, var. flore pleno.
,, ,, ,, juliana.
,, ,, ,, pendula.
,, japonica.
,, ,, var. alba.
,, ,, ,, rosea.
,, serrulata.
,, pseudo-cerasus.

Section 5.—*Padus.*

Prunus Mahaleb.
,, ,, var. pendula.
,, Padus.
,, serotina.
,, virginiana.

Section 6.—*Laurocerasus.*

Prunus Laurocerasus.

Pyrus.

Section 1.—*Pyrophorum.*

Pyrus auricularis.
,, Michauxi.
,, nivalis.
,, sinensis.

Section 2.—*Malus.*

Pyrus Malus.
,, ,, var. pendula.
,, ,, ,, rosea.

Pyrus prunifolia.
,, ,, var. fructu coccineo.
,, ,, ,, fructu striato.
,, Ringo.
,, spectabilis.
,, ,, var. flore albo.
,, ,, ,, flore pleno.
,, Toringo.
,, Toringo spectabilis flore pleno.

Section 3.—*Aria.*

Pyrus Aria.
,, Torminalis.

Section 4.—*Sorbus.*

Pyrus Aucuparia.
,, ,, var. fructu luteo.
,, ,, ,, pendula.
,, Sorbus.

Section 5.—*Adenorachis.*

Pyrus arbutifolia.

Section 6.—*Cydonia.*

Pyrus japonica.
,, ,, nivalis.
,, Maulei.
,, Cydonia.
,, ,, var. Champion.
,, ,, ,, Meech's Perfection.

Section 7.—*Mespilus.*

Pyrus germanica.

In the same strip of ground, as well as in the border on the south-east boundary of the field, a considerable number of apple, pear and plum stocks have been planted for budding or grafting purposes.

In other portions of the ground, where the nature of the experiments did not preclude it, the spaces between the trees have been utilised by planting currants, gooseberries and strawberries.

Collection of Plants of Special Interest.

In a small plot of ground near the garden house a collection of various trees, shrubs and plants possessing some special features of interest is being formed. At present the collection consists of:—

Botanical Name.	Popular Name.	Natural Order.	Remarks.
Rosa indica viridi flora	Rose verte	Rosaceæ	Flowers green.
Asarum europæum	Asarabacca	Aristolochiaceæ	Peculiarly-formed flowers.
„ canadense	„	„	
Equisetum telmateia fluviatile.	Giant horsetail	Equisetaceæ	Interesting floral and stem structure.
Juglans regia monophylla.	Walnut	Juglandaceæ	Leaves with one leaflet.
„ laciniata	„	„	Strangely cut leaves.
„	„ Franquette nain	„	Dwarf variety.
Rubia tinctorum	Madder	Rubiaceæ	Celebrated dye.
Isatis tinctoria	Dyer's Woad	Cruciferæ	Used from ancient times as a dye.
Rubus (hybridus)	Logan Berry	Rosaceæ	Hybrid between raspberry and blackberry.
Phytolacca decandra	Virginian Poke-weed	Phytolaccaceæ	Peculiar fruits.
Saxifraga peltata		Saxifrageæ	Remarkable leaves.
Asclepias incarnata		Asclepiadaceæ	Strangely-formed, but attractive flowers.
„ princeps		„	
„ speciosa		„	
Berberis vulgaris	Berberry	Berberidaceæ	Ordinary variety.
„ „ asperma	„	„	Variety with seedless fruits.

Botanical Name.	Popular Name.	Natural Order.	Remarks.
Fragaria lucida	Strawberry	Rosaceæ	Wild forms of Fragaria.
„ monophylla	„	„	
„ chiloensis	„	„	
„ vesca	„	„	
„ variegata	„	„	
„ Hagenbachiana	„	„	
„ indica	„	„	
Ribes Grossularia	Belle de Meaux	Saxifragiæ	French varieties of gooseberries, said to be thornless.
	Edouard Lefort	„	
	Souvenir de Billard	„	
	Madame Lefort	„	
Pyrus Malus	D'Arcy Spice	Rosaceæ	Small-growing apple trees on pigmy stocks.
	Egremont Russet	„	
	Mannington's Pearmain	„	
	Wadhurst Pippin	„	
	Cornish Gilliflower	„	
	Golden Russet	„	
Prunus (? triflora)	Botan	Rosaceæ	Japanese plums, said to be free fruiting and of fine quality.
	Ogden	„	
	Hatankio Maru	„	
	„ Togari	„	
	Kelsey	„	
	Satsuma	„	
Abies excelsa clanbrasiliana,	..	Coniferæ	Pigmy firs and pines.
„ excelsa pygmæa	..	„	
„ excelsa Gregoriana.	..	„	
„ monstrosa	..	„	
Juniperus communis compressa.	..	,	
Taxus baccata ericoides	..	„	
Ribes Grossularia	London	Saxifrageæ	Standard trees, Continental origin.
Ribes rubrum album	White cherry	„	

Experiments on Canker of Apple Trees.

Although canker in the apple tree has been investigated scientifically, much work yet remains to be done on the subject. The precise connection between the fungus and the disease, the part of the tree in which the former obtains a nidus, and the predisposing causes which render a tree susceptible, require elucidation; and the question of preventives and remedies, as well as that of the varieties and the stocks which are most subject to attack, open a considerable field for enquiry.

With this object in view a number of bush trees were planted in 1895, but in order to avoid infecting other trees in the Woburn ground, the plantation was formed at Harpenden. The soil there is yellow clay with flints in it, resting on chalk, which is several feet below the surface. The majority of the trees for the experiment were planted in an old garden of a quarter-acre area, in which the surface soil is dark and rich in organic matter. Four three-year-old bush trees of each of 25 varieties of apples were planted, two being on the crab stock, and two on the paradise, and the duplicates on the same stock were planted as far from each other as possible. In the case of six of the varieties marked by an asterisk in the following list, two other similar plantations were made, where the conditions were different. In the one case, the ground was more open than in the old garden, but the soil was much heavier, being the natural clay subsoil with very little surface soil, which had been broken up and brought into cultivation only a few years previously; in the other case, the trees were planted in the midst of an old grass-grown orchard, where the soil is probably much exhausted, and where the trees are under very unfavourable conditions as to air and light.

When the trees are well established and healthy they will be artificially infected in various ways with a pure cultivation of the canker fungus. Unfortunately this operation will be delayed, owing to a large number of the trees having suffered through the very dry season (1896) following their plantation. The damage suffered by these trees gives an excellent illustration of how much more liable trees on the crab stock are to suffer under such circumstances than those on the paradise: out of 74 trees on the latter stock only four failed to "start" satisfactorily, whereas out of a similar number on the crab as many as 35 did not start well, and, of these, 14 were so nearly dead that they have had to be replaced by fresh trees.

The following is a list of the varieties planted:—

Worcester Pearmain.
New Northern Greening.
*Ribston Pippin.
Duchess of Oldenburg.
*Cox's Orange Pippin.
*Bramley's Seedling.
*King of the Pippins.
*King of Tompkins Co.
Cellini.
Peasgood's Nonesuch.
Gascoyne's Seedling.
Blenheim Orange Pippin.
Dumelow.
*Lord Grosvenor.
Lord Suffield.
Ecklinville.
Mr. Gladstone.
The Queen.
Stirling Castle.
New Hawthornden.
Annie Elizabeth.
Cox's Pomona.
Prince Albert.
Bismarck.
Mannington's Pearmain.

662 to 667.†—Experiments on Dressing Strawberries with Stable and Artificial Manure.

Six similar plots, each containing 48 plants of six varieties of strawberries, were planted in 1896, and each plot will be dressed either with stable or artificial manure in different quantities.

† These and the following are additional plots planted after the above description had been set up in type.

The details of the treatment are as follows:—

Experiment.	Treatment.
662	No manure.
663	Stable manure: 12 tons to the acre in autumn.
664	„ „ 30 „ „ „
665	Artificial manure: 278 lbs. mixed minerals in autumn, and 97 lbs. nitrate in spring, per acre.*
666	Artificial manure: 695 lbs. mixed mineral in autumn, and 243 lbs. nitrate in spring, per acre.†
667	Artificial manure: ditto, but half the minerals applied in the autumn, and half in the spring.

668 to 671.—Repetition Experiments on Cutting Back Standard Trees when Planted, or later.

Experiment.	Treatment.
668	Bramley's seedling apple, on crab stock: cut back at once after planting.
669	Bramley's seedling apple, on crab stock: cut back one year after planting.
670	Victoria plum: cut back at once after planting.
671	„ „ cut back one year after planting.

672.—Collection of Peaches, Nectarines and Apricots.

A small collection of the hardier varieties of peaches, nectarines and apricots has been made, the trees lein

* The same dressing as that used in the apple plots, Nos. 1 to 60, and probably equivalent to 12 tons of stable manure.

† The same dressing as that used in the demonstration plots, and probably equivalent to 30 tons of stable manure.

in the form of bushes, and being planted in the open. The following are the varieties represented:—

Peaches—	Nectarines—	Apricots—
Royal George.	Hardwicke.	Hemskerke.
Walburton Admirable.	Elruge.	Moorpark.
Barrington.	Balgowan.	Shipley's.
Sea Eagle.	Humboldt.	Peach.
Violette Hâtive.	Stanwicke Elruge.	
Bellegarde.	Violette Hâtive.	

Kashmiri Apples.

A number of scions of apples from Kashmir have been recently received, and have been grafted on to both paradise and crab stocks. The most interesting of these apples is the Trel. This is described as being small in size, and yellow or red in colour, according to the variety, with a delicious taste—half sour, half sweet—and possessing, when rotten, a flavour exactly like that of the medlar.

The varieties of which there are representatives in the ground are—

Buth Trel.
Trel of a large variety.
Kichahâma Trel (a local variety).
Tet Shakr (a wild apple of good flavour).
Kuddu Sari (said to have been introduced from Kabul).

PART II.—EXPERIMENTAL RESULTS.

Experiments chiefly on Apple Trees.

THE amount and quality of the fruit obtained from a fruit tree must necessarily form the ultimate criterion of the relative merits of the treatment to which it has been subjected. Our trees, however, are at present too young to yield any certain results by examining their crops, indeed, the past season is the first one in which they were allowed to bear at all, and it is questionable whether any conclusions could ever be drawn from a single year's crop. But with young trees it is more important that they should grow, and form as quickly as possible healthy and well-developed trees, than that they should bear fruit; and for the measurement of the vigour of trees there are several features available. Those which we have used are—

(1.) The size of the leaf.
(2.) The total leaf-area on the tree.
(3.) The length of new wood formed.
(4.) The number of new shoots on the tree.

In a few cases we have also measured the total weight of leaves on the trees.

As it has not been practicable to measure the total leaf-area in the second season after planting, owing to the labour which doing so would entail, our results, which apply chiefly to the second season (1896), will deal principally with the three other methods enumerated.

It cannot, of course, be assumed that the health and vigour of a tree is directly proportional to any of these features—that a tree, for instance, which has leaves of double the size of another, possesses double the health and vigour of this other; indeed, it is extremely improbable that such a strict proportionality exists. We can, also, not expect every different method of treatment to affect the different features examined, either to the same extent, or even in the same direction, nor can we expect the different varieties of trees under experiment to be equally responsive to different treatment. For these reasons it is obvious that the numerical results obtained by the different methods, and on different varieties of trees, cannot agree exactly; at the same time, unless there is a certain amount of agreement between them, we shall have no evidence that the methods adopted can be relied upon at all. It is, therefore, most important that the results should be compared together critically, and this we propose to do before discussing the advantages or disadvantages of the various treatments.

Methods of Examination.

The trees forming the subject of the present examination were chiefly the dwarf apple trees, Nos. 1 to 60; the standard apple trees, Nos. 189 to 225: a few other plots of similar apple trees, and some pear and plum trees are also included. Details of the different methods of treatment have already been given (pp. 14–19).

In 1895, the first season after planting, only a few of the experimental plots were examined, but in the next season the examination was much more extensive, and,

considering the satisfactory character of the results obtained, we regret that we did not measure the leaf-size of the whole of the trees under experiment.

Leaf-size.

In 1895 the measurements of leaf-size were made in the first instance by selecting what appeared to be an average-sized leaf on a branch, and determining its length and breadth. For each experiment about a hundred leaves were measured. In a subsequent series of measurements the sixth leaf from the end of each shoot was taken. The two series agreed very well with each other. The values for normally treated trees were obtained by measuring leaves on such trees here and there throughout the whole plots, and taking the mean.* These measurements were made in July.

In 1896 the measurements were confined to the sixth leaf from the ends of the shoots, and to six shoots on each tree, selecting shoots which were disposed at about equal intervals round the tree. There are, therefore, 36 measurements of each variety of apple tree in each experiment. The measurements in 1896 were made in August, and several of them repeated in September. The repetitions showed that no alteration in the size of the leaf had occurred in the interval.

The following copy of a set of measurements of one lot of six trees will make the method clear, and will give a fairly typical example of the variation found in trees in the same experiment, and in the leaves of the same tree. The length (*l.*) and breadth (*b.*) of the leaves are given in millimetres

* As manures were not applied till the end of 1895, a considerable number of plots were available at this time as normal ones.

Cox's Orange Pippin, Plot 20.

—	1st Tree.	2nd Tree.	3rd Tree.	4th Tree.	5th Tree.	6th Tree.
	l. × *b.*	*l.* × *b.*	*l.* × *b.*	*l.* × *b.*	*l.* × *b.*	*l.* × *b.*
1st leaf -	74 × 35	77 × 38	78 × 41	78 × 40	73 × 41	73 × 36
2nd „ -	73 × 34	74 × 39	73 × 38	60 × 33	65 × 44	68 × 36
3rd „ -	72 × 38	60 × 34	74 × 39	62 × 31	78 × 44	72 × 38
4th „ -	70 × 36	58 × 29	78 × 40	58 × 29	72 × 41	85 × 40
5th „ -	79 × 43	63 × 31	70 × 36	65 × 34	65 × 36	56 × 29
6th „ -	78 × 41	70 × 32	64 × 34	72 × 36	71 × 41	71 × 37
Mean -	74·3 × 36·8	67·0 × 33·8	72·8 × 38·0	65·8 × 33·8	72·3 × 41·2	70·8 × 36·0

Mean for the six trees = 70·6 × 36·8 = 1,949 : mean area = 1,462.

The area, it will be seen, is taken to be three-quarters of the length × breadth, and it was found to be very closely so in the case of the three varieties under investigation. The constants obtained with Bramley, Cox, and Potts were 0·733, 0·765, and 0·752 respectively.* It is immaterial, however, for the present purposes whether the constants are the same with each variety, or whether, indeed, the true area, or merely the length × breadth, is taken: the only point which might affect the results a little is if any alteration occurs in the value of the constant with different sized leaves of the *same* variety; but leaves of very different sizes were found to give sensibly the same constant. It may be noted, also, that the average area, as deduced from the average length and breadth, is not necessarily the same as that which would be obtained by taking the mean of the areas of each leaf worked out separately: but this, again, is quite immaterial for our present purposes.

The average length × breadth, when determined as in the above instance, was then compared with that

* They were ascertained by cutting out facsimiles of the leaves on a sheet of paper, weighing these, and comparing their weights with that of a measured area of the paper.

of the leaves in the normally treated trees in the neighbouring plots. This was 2,175; and, hence, the treatment adopted in plot 20 has resulted in a loss of 10 per cent. in the size of the leaf. A repetition of the measurements of different leaves of the same plot gave a loss of 6 per cent.

From the variation between duplicate measurements of the same six trees in various cases, it appears that the probable experimental error of a single set of measurements with Bramley is $\pm 2{\cdot}8$ per cent., with Cox $\pm 1{\cdot}4$, and with Potts $\pm 2{\cdot}5$. These are the errors inherent in the process of measurement: they do not include those which are due to the variation in the trees constituting the plot measured; but the latter appear to be of very small magnitude, for, by examining the divergence of the results from the single trees composing any plot, we can determine the total error, which includes that due to the variation in the trees, as well as that due to the process of measurement, and we find that this total error is little more than that due to the process of measurement alone—it is $\pm 2{\cdot}8$ per cent with Bramley, $\pm 3{\cdot}6$ with Cox, and $\pm 2{\cdot}8$ with Potts.* Making an allowance for the error in the measurement of the normal plots with which the results are compared (which, however, will be smaller than the above, since the normal values are deduced from the smoothed curve derived

* To determine the total error, six sets of results with each variety were selected at random from the note book.

The probable error of any single measurement is given by $\pm\frac{2}{3}\sqrt{\frac{S}{n-1}}$, where S is the sum of the squares of the differences of the individual measurements from their arithmetical mean, and n the number of these results. The probable error of the mean of the measurements is $\pm\frac{2}{3}\sqrt{\frac{S}{n(n-1)}}$.

In some of the duplicate measurements of the same plots, branches other than those taken for the first measurement were purposely selected.

from a whole series of values, and not from one set of measurements only), we may safely put the probable error of results with any set of six trees at something less than about ± 5 per cent.

In making measurements such as these, where the results may be dependent to a certain extent on the particular branches selected, it is important to guard against any conscious or unconscious prejudice on the part of the person taking the measurements. All the measurements were made by our manager, Mr. L. Castle, and dictated by him to an assistant, but neither of these worked out the results, nor even took the means of the observations, so that they were entirely in ignorance of the nature of the results; and we have thoroughly satisfied ourselves in various ways that the measurements have been taken most carefully, and are entirely free from any personal element.

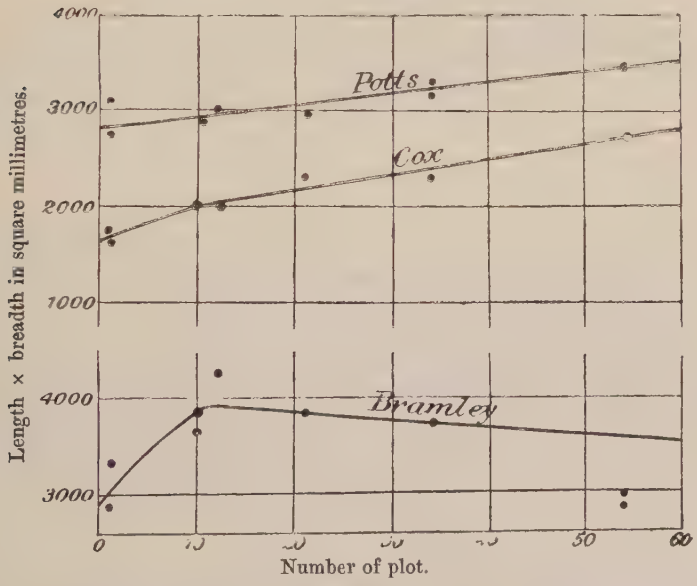
Of the six normal plots, which are distributed over the ground for the purpose of comparison, No. 56 is of no use, owing to the trees having had to be replanted in 1895. No. 54 was taken as a normal plot in place of it: here Thomas' slag in lumps had been dug into the soil, but as the slag has at present undergone hardly any visible decomposition, its effect cannot have been appreciable. There are several other plots which are at present normal, and which have been utilised as such, especially in the case of the growth-measurements to be mentioned shortly.

The measurements of the normal plots are plotted out in Fig. 5. The values at the side of this diagram give the length $\times$ breadth of the leaf in square millimetres, and those at the bottom give the numbers of the plots. As the plots are equidistant from each other, the latter represent the position of the plots in the ground,

and, following the figures from left to right, we see in what way the results vary as we pass from the higher to the lower part of the ground.* The same set of marginal values refer to Potts and Cox; a separate set has had to be used for Bramley.

With Potts' Seedling, which are planted most to the south-east (*see* Plan), the values all lie, within experimental error, on a straight line, showing a uniform increase in leaf-size as we pass from the higher to the lower ground, the increase being from 2,900 to 3,500 square millimetres,† or 17 per cent.

FIG. 5.—LEAF-SIZE OF THE NORMAL PLOTS OF DWARF APPLE TREES.



* Allowance has not been made for two roads which cross the plots, so the numbers of the plots do not exactly represent their distance from the top of the ground; but the error thus introduced is too slight to be appreciable, and complication is avoided by not making such an allowance.

† Although the values given are those for length × breadth, it will be convenient to speak of them as leaf-size.

With Cox's Orange Pippin, which are to the north-west of Potts, the results from No. 10 onwards are of the same character, they, also, showing a uniform increase, representable by a straight line; the increase here, however, is greater, amounting (from Nos. 10 to 60) to 40 per cent. The results with plot 1 show that in the highest portion of the ground the values are slightly lower than they would be if they were quite uniform with the rest of the series.

This lowness becomes still more marked in the case of Bramley's Seedling, which are planted still further to the north-west, the increase in leaf-size from plot 1 to plots 10 and 12 being very considerable. Bramley also shows another marked peculiarity, in that the values from plots 10 or 12 down to 60 show a decrease, instead of increase, in leaf-size, this decrease amounting to about 10 per cent. It will be seen that the values at No. 54 are far below the line which has been drawn: half the trees in this plot appear to be exceptionally feeble, and, as they are in a direct line with a large oak tree about 50 feet distant, it is possible that they have been affected by it; we have, therefore, decided to omit them from consideration, and to take, as representing the normal values, the straight line formed by joining the values for 34, 21 and the mean of those for 10 and 12. That this straight line is really applicable from 34 to 60, we shall find strong proof in the close concordance of many of the values deduced from it with those obtained in the case of Cox and Potts.

The general increase in vigour shown by Cox and Potts as we pass from the higher to the lower part of the ground is what might be naturally expected, owing to an increase in the moisture of the soil with

the lowness of the situation, and this would be especially beneficial in exceptionally dry seasons, such as 1895 and 1896. Why Bramley, on the contrary, should show a decrease is not clear. It may be due to the fact the plots of Bramley come nearer, as they get lower, to the boundary hedge of the ground, where there are several large trees, which may have exhausted the soil; but the effect seems to start at too high a point (No. 12), and at too great a distance from this hedge (200 ft.), to render such an explanation acceptable.

The regularity in the variation of the normal results with their position in the ground is remarkable, in view of the marked changes occurring in the nature of the soil (*see* p. 7); but although these do not appear to have had any influence on the leaf-size, they have affected the growth, as will be mentioned below.

As it is evident that the leaf-size of the normally-treated trees varies with their position in the ground, we shall obtain correct values for the effect of any special treatment only by comparing the leaf-size of the trees subjected to it with that which normally-treated trees would have given in the same position; that is, we must take for the normal values the readings given by the figures as drawn in Fig. 5. Thus, with the results with Cox, No. 20 (*see* p. 60), where the leaf-size was 1,949, the normal value corresponding to this position is 2,175, and that is taken as the standard with which the 1,949 is compared. If the experiment had been No. 40, the standard of comparison would have been 2,480.

The results expressed in this way are given in Table 2, and will be discussed in detail further on. The values obtained with the trees in 1895, one year after they were planted, are given in square brackets;

the others refer to 1896, the second year after planting, except in Nos. 19, 56, 57 and 58, where they were replanted one year later.

TABLE 2.—PERCENTAGE INCREASE (+) OR DECREASE (−) IN SIZE OF LEAF OF APPLE TREES CAUSED BY DIFFERENT TREATMENT.

The measurements were made in 1896, *the second year after the trees were planted, except where otherwise stated.*

Plot.	Treatment.	Bramley.	Cox.	Potts.	Stirling Castle.	Mean.
2	Cut back at end of first year	+ 5	+ 31	+ 25	..	+ 20
3	Cut back on planting; no subsequent pruning.	+ 7	+ 32	+ 23	+ 10	+ 18
4	No cutting nor pruning	− 21	− 28	− 32	..	− 27
[4	„ „ 1895	− 17	− 21	− 35	..	− 24]
9	Summer pruning only	− 20	+ 10	− 17	..	− 9
14	Root pruned	− 54	− 34	− 30	..	− 39
17	Grass grown	− 38	− 38	− 30	..	− 35
18	Hardened ground	− 29	− 13	− 9	..	− 17
19	Weeds †	− 48	− 30	− 54	..	− 44
20	Dug near roots	− 13	− 8	− 2	..	− 8
22	No phosphate	− 4	− 8	− 6	..	− 6
23	No potash	− 3	+ 10	− 3	..	+ 1
24	No nitrate	− 13	+ 14	+ 3	− 5	0
27	Dunged before planting	− 8	+ 7	0	..	0
32	No manure	− 22	− 25	− 23	..	− 23
33	Half ordinary manure	− 10	− 10	− 13	..	− 11
40	Nitrate in July	− 11	− 10	− 6	+ 2	− 8
42	Badly planted	− 22	− 35	− 18	..	− 25
[42	„ „ 1895	− 38	− 31	− 32	..	− 34]
43	Neglected and restored	− 7	− 29	+ 6	..	− 10
44	Neglected	− 53	− 58	− 58	..	− 56
[44	„ 1895	− 77	− 72	− 77	..	− 75]
45	Ground not trenched	− 9	− 22	− 19	..	− 17
46	Planted in three-feet holes	+ 19	+ 3	+ 3	..	+ 8

† *See* Note (†) on next page.

TABLE 2.—PERCENTAGE INCREASE (+) OR DECREASE (−) IN SIZE OF LEAF OF APPLE TREES CAUSED BY DIFFERENT TREATMENT—*continued.*

Plot.	Treatment.	Bramley.	Cox.	Potts.	Stirling Castle.	Mean.
48	Planted too high	0	− 17	− 3*	..	− 7
49	„ „ low	+ 5	− 21	− 6	..	− 7
53	Peat	+ 6	− 2	+ 8	..	+ 4
55	Compost	+ 5	+ 4	+ 34	+ 20	+ 16
56	Replanted November 1895	− 54	− 53	− 53	..	− 53
57	Planted in January, 1896†	+ 5	+ 5	+ 2	..	+ 4
58	Planted in March, 1896†	+ 6	+ 2	+ 12	..	+ 7
59	Blossoms removed	− 19	− 6	+ 18	..	− 2
60	Damaged trees	0	− 8	− 7	..	− 5

* Omitting two trees, which died and were replaced by others in 1895, this becomes + 7, and the mean − 3.

† The trees in these plots and in No. 56 were replanted in 1895–6, and the standard of comparison for them is No. 56, due correction being made for the difference in the position of the plots in the ground.

Standards.

Plot.	Treatment.	Bramley.	Cox.	Prince Albert.	Mean.
189&c.	Grass grown	− 45	− 47	− 31	− 41
224	Weeds grown	..	..	− 30	− 30
196&c.	Neglected	− 37	− 27	− 24	− 28

Total Leaf-area.

The total leaf-area of a tree was obtained by multiplying the mean area of the single leaf, measured as above, by the number of leaves on the tree. Unless the leaves measured really represent the average of the various leaves on the tree, this will not, of course, give

the true total leaf-area; but, as the results are merely comparative, this is a matter of no importance. With trees in their second year after planting, the counting of the leaves was too laborious and uncertain to be undertaken generally, and, owing to the great variation in the size of the leaves, would not have given any dependable results.

Leaf-weight.

In cases where this was determined, ten leaves were taken from each plot; these were measured as well as weighed, so that the data obtained gave the weight per unit area of leaf-surface, and, combining this value with the total leaf-area, we get the total leaf-weight of the tree. The leaves taken were the sixth ones from the ends of the shoots.

It is very necessary that the leaves which are being compared should be weighed under similar conditions, preferably after drying at 100° C., as they lose moisture very rapidly.

The weight of leaf per unit area is practically a measure of the thickness of the leaf.

Wood Growth.

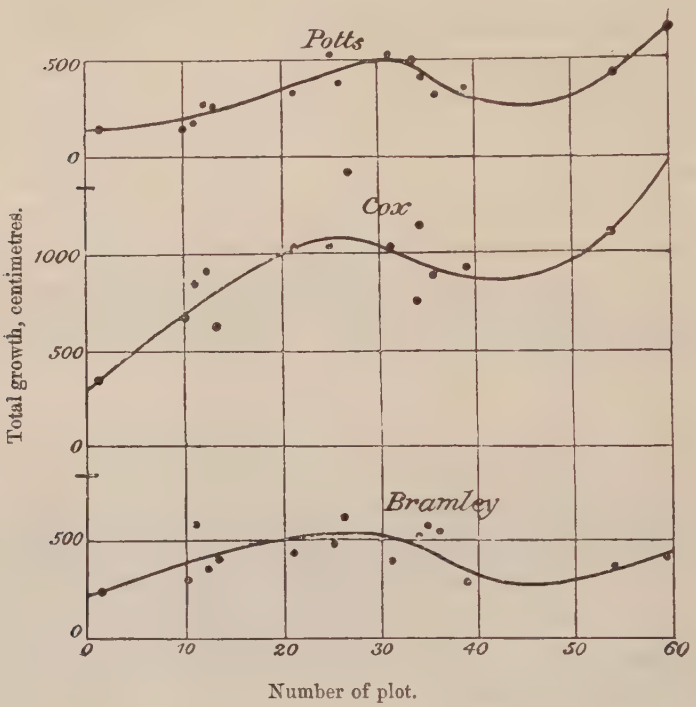
In measuring the length of new wood formed during the year, any growth of less than 1 c.m. (0·4 inch) was neglected, and, as the growths of the main and lateral branches of the trees were entered separately,

the number of the latter, which is one of the features utilised, was obtained at the same time as the measurements.

Since the measurement of the growth is not subject to unconscious prejudice on the part of the measurer, as in the case of the leaf-size, no repetitions of it were made on the same plot; but the mean error of a single set of observations (which, in this case, will be due almost entirely to variations in the vigour of the trees) may be determined accurately enough by comparing the values obtained from those normal plots which are in each other's immediate vicinity. The values thus obtained were $\pm$ 17, $\pm$ 22, and $\pm$ 19 per cent. in the case of Bramley, Cox and Potts respectively, and these values include errors in the process of measuring, as well as errors due to peculiarities in the trees measured. The former source of error is, in this case, very small, and the total error is, therefore, mainly attributable to the variation in the individual trees. It is much greater than in the case of the leaf-size, but its magnitude is partly compensated by the fact that differences of treatment cause a larger percentage alteration in the growth of wood than in the size of the leaf. The variation in the growth of similarly treated trees is certainly very great, there being but few instances where, out of a set of six trees, some did not show a growth two or three times greater than others, and it is rather surprising to find that the general results are as concordant as they will be shown to be.

The values for growth measurement of the normal plots are given in Fig. 6. A larger number of normal plots were taken in this case, and plot No. 60 (damaged trees) was also taken as normal: as to leaf-size it showed only a very slight deficiency below the normal.

FIG. 6.—TOTAL LENGTH OF NEW WOOD FORMED IN 1896 BY THE DWARF APPLE TREES IN THE NORMAL PLOTS.



The general character of the figures is very different from that of the leaf-size, and harmonizes better with what might be expected from the character of the soil. There is a general increase of growth as we pass to the lower, and presumably moister, portions of the ground, the increase attaining a maximum at about No. 30. The band of apparently poorer soil which occurs below this point (*see* p. 8) produces a reduction in the growth, and this is followed in the still lower portions of the ground by a very rapid increase as the rich dark soil is reached.

The total growth of Cox is about double that of the other varieties, but the variation which it exhibits is almost the same as with Potts: from No. 1 to No. 60 the growth of Potts increases 333 per cent., and that of Cox 355 per cent. Bramley shows a much smaller amount of variation. The variation of the growth of the normal trees in different parts of the ground is much greater than in the case of the leaf-size, and the same will be found to hold good when we come to compare the effect of different methods of treatment.

In No. 27 the value for Cox is very high, but, as this is caused mainly by the value for one very exceptional tree, not much weight has been given to it in drawing the smoothed curve. The normal values for Bramley between the plots 39 and 54 are very doubtful. On looking at Table 3, which contains the results, it will be seen that Bramley shows very high values as compared with the other varieties, this being especially so with the plots from 45 to 52. We believe that this is due to their position of the ground, being sheltered in an exceptional manner, and, though the rest of the Bramley plots from 54 downwards may be similarly affected, the result has been neutralised by the impoverishment of the ground by large trees in the vicinity (*see* p. 65). We have thought it best, therefore, in the case of plots 45 to 52, to omit Bramley in taking the means, and the results would, perhaps, have been better if a similar omission had been extended to plots 40 and 53. It is noticeable that this irregular behaviour of Bramley in this part of the ground is confined to the growth, and does not appear either in the leaf-size or number of shoots.

In the case of the standard trees there are two plots of each variety which are at present normal, and with which the others have been compared.

Table 3.—Percentage Increase (+) or Decrease (−) in the Length of New Wood of Apple Trees caused by different Treatment.

The measurements, except where otherwise stated, are those of the growths made during 1896, the second year after planting.

Plot.	Treatment.	Bramley.	Cox.	Potts.	Stirling Castle.	Mean.	
						Of all.	Omitting Bramley.
		I.	II.	III.	IV.	V.	VI.
2	Cut back end of first year	+ 62	+ 57	+108	..	+ 76	..
3	Cut back when planted; no pruning.	+ 17	+ 29	+ 95	+ 1	+ 35[4]	..
4	Not cut back nor pruned	− 79	− 78	− 70	..	− 76	..
[4	Not cut back nor pruned, 1895.	− 86	− 79	− 84	..	− 85]	..
5	Moderate pruning; no summer shortening.	− 38	− 5	+ 6	..	− 12	..
6	Hard pruning; no summer shortening.	− 26	− 5	+ 2	..	− 10	..
7	Moderate summer shortening; no autumn pruning.[1]	− 13	− 46	− 2	..	− 20	..
8	Hard summer shortening; no autumn pruning.[1]	− 65	− 74	− 53	..	− 64	..
9	Summer pruning; no autumn pruning.	− 70	− 81	− 38	..	− 63	..
14	Root pruned	− 92	− 90	− 91	− 92	− 91	..
15	Lifted	− 12	− 37	− 18[3]	..	− 22	..
16	Mulched with straw	− 28	− 13	− 22	..	− 21	..
17	Grass grown	− 89	− 96	− 77	..	− 87	..
18	Ground hardened	+ 8	0	+ 24	..	+ 11	..
19	Weeds grown, 1896 = first year.[2]	− 76	− 79	−100	..	− 85	..
20	Ground dug near roots	− 15	+ 5	+ 17	..	+ 2	..
22	No phosphate	− 5	− 12	+ 8	..	− 3	..
23	No potash	− 2	+ 5	− 9	..	− 2	..
24	No nitrate	− 23	+ 10	+ 15	+ 13	+ 4	..
27	Dunged before planting	− 29	0	+ 13	..	− 5	..
28	Dunged every year	+ 8	+ 14	− 21	..	+ 4	..

[1] The treatment of these plots having been altered after 1896, the description in this Table is different from that in the Table on p. 15, which gives the present treatment.

[2] The values for 56 are the standards of comparison for this plot. *See* foot-note to Table 2.

[3] One very exceptional tree omitted.

[4] Owing to losses, only two trees of Potts were available in this plot; the values for them have, therefore, been omitted in taking the mean.

TABLE 3.—PERCENTAGE INCREASE (+) OR DECREASE (−) IN THE LENGTH OF NEW WOOD OF APPLE TREES CAUSED BY DIFFERENT TREATMENT—*continued.*

Plot.	Treatment.	Bramley. I.	Cox. II.	Potts. III.	Stirling Castle. IV.	Mean. Of all. V.	Mean. Omitting Bramley. VI.
29	Ammonia instead of nitrate.	+ 6	− 16	(− 54)[2]	..	− 11	..
30	Ammonia, but no potash	+ 10	+ 4	− 26	..	− 4	..
32	No manure	− 14	− 4	− 14	..	− 11	..
33	Half-dose of manure	− 19	+ 11	− 31	..	− 13	..
37	Minerals in spring	+ 25	− 8	+ 16	..	+ 11	..
38	„ summer	+ 17	− 28	− 16	..	− 9	..
40	Nitrate in summer	+ 83	+ 4	+ 72	+ 30	+ 47	..
41	„ autumn	+ 79	+ 27	+ 45	..	+ 50	..
42	Badly planted	+ 63[3]	− 10	+ 39	..	+ 31	+ 15
[42	„ „ 1895	+ 15	− 2	+ 15	..	+ 6]	..
43	Neglected and restored	+ 22	− 46	− 36	..	− 20	− 41
44	Neglected	− 89	− 97	− 96	..	− 94	− 97
[44	„ 1895	− 95	− 95	− 90	..	− 93]	..
45	Ground not trenched	+122	− 4	+ 7	..	(+ 42)	+ 2
46	Three-feet holes	+204	+ 36	+ 45	..	(+ 95)	+ 41
47	Holes with chalk bottoms	+221	+ 29	+ 5	..	(+ 85)	+ 17
48	Planted too high	+110	− 12	− 14	..	(+ 28)	− 13
49	„ „ low	+106	+ 24	+ 47	..	(+ 59)	+ 36
50	Chalk mixed with soil	+ 37	− 32	+ 15	..	(+ 7)	− 9
51	Stones „ „	+ 75	− 33	− 1	..	(+ 21)	− 17
52	Gravel „ „	+ 48	− 67	− 8	..	(− 14)	− 38
53	Peat „ „	+100	+ 51	+ 52	..	+ 68	+ 52
55	Planted in compost	+ 30	+ 49	+ 84	+ 127	+ 75[4]	..
56	Replanted Nov. 1895	− 90	− 91	− 94	..	− 92	..
57	Planted in winter 1896, first year.[1]	+ 68	+ 78	+ 29	..	+ 58	..
58	Planted in spring 1896, first year.[1]	− 22	+ 10	+ 50	..	+ 13	..
59	Blossoms removed	− 13	+ 27	+ 37	+ 136	+ 47[5]	..

[1] The values for 56 are the standards of comparison for this plot. *See* foot-note to Table 2.

[2] Omitting Stirling Castle, the mean is + 47.

[3] Omitting one exceptional tree, this value becomes + 42, and the mean + 24.

[4] Omitting Stirling Castle, the mean becomes + 54.

[5] Omitting Stirling Castle, the mean becomes + 26.

Standards.

Plot.	Treatment.	Bramley.	Cox.	Prince Albert.	Mean.
189 [1]	Grass grown - -	− 77	− 84	− 61	− 74 (− 87) [2]
190 [1]	No summer shortening -	− 4	− 22	+ 19	− 2 (− 12)
192 [1]	Summer shortening only -	+ 18	− 17	+ 34	+ 12 (− 20)
193 [1]	No nitrate - - -	+ 10	− 19	+ 29	+ 7 (+ 4)
194 [1]	Summer pruning - -	+ 6	− 14	− 8	− 5 (− 64)
196 [1]	Neglected - - -	− 70	− 61	− 55	− 62 (− 94)
197 [1]	Nitrate in July - -	+ 7	+ 7	− 23	− 3 (+ 47)
198 [1]	Planted too low - -	+ 4	− 27	− 7	− 10 (+ 36)
199 [1]	Holes with chalk bottoms	+ 35	+ 15	+ 36	+ 29 (+ 17)
224	Weeds grown - -	..	..	− 43	− 43 (− 85) [3]
225	Blossoms removed - -	..	..	+ 22	+ 22 (+ 47)

[1] Numbers of the plots of Bramley.

[2] The values in parentheses in this column give the mean values obtained by similar treatment with bush trees; but the varieties investigated are not all the same in the two cases.

[3] Value for bush trees the first year after planting.

Number of Shoots.

The length of new wood formed is not necessarily a true indicator of the vigour of the tree, for that growth may be either firm or weedy; a more satisfactory indication would be the weight of wood formed, but that could not be ascertained without either destroying the tree, or expending an amount of labour quite incommensurate with the value of the results. The number of growing shoots on a tree, however, affords some check on the interpretation of the values from the growth, for in cases where the growth is large, but the number of growing shoots small, the tree will not be bushy, and the growth will, presumably, be weedy.

The data for the number of side-shoots have been treated in the same way as with the other properties, and the results are similarly set out in Table 4. It is

scarcely necessary, however, to reproduce the diagrams for the normal plots, as they very closely resemble those for the growth—an increase to about plot 35, followed by a decrease, and then by a subsequent increase: the variation, however, is less than in the case of the growth. With Potts the number of side-shoots per tree varies from 12 to 21, with Cox from 12 to 25, and with Bramley from 10 to 13.

TABLE 4.—PERCENTAGE INCREASE (+) OR DECREASE (−) IN THE NUMBER OF GROWING SHOOTS OF APPLE TREES CAUSED BY DIFFERENT TREATMENT.

Growth of 1896, *except where stated otherwise.*

Plot.	Treatment.	Bramley.	Cox.	Potts.	Stirling Castle.	Mean.
2	Cut back at end of 1st year	+ 23	+ 20	+ 4	..	+ 16
3	Cut back; not pruned	− 18	− 22	+ 2	− 6	− 11
4	Not cut back nor pruned	− 44	− 62	− 52	..	− 53
[4	„ „ 1895	− 67	− 37	− 70	..	− 58]
5	Moderate pruning; no summer shortening.	− 15	+ 4	− 40	..	− 17
6	Hard pruning; no summer shortening.	− 34	+ 11	− 42	..	− 22
7	Moderate summer shortening; no pruning.	+ 2	− 15	− 8	..	− 7
8	Hard summer shortening; no pruning.	− 24	− 34	− 42	..	− 33
9	Summer pruning	− 34	− 31	− 32	..	− 32
14	Root pruning	− 56	− 50	− 68	− 72	− 62
15	Lifted	− 7	− 22	− 50	..	− 26
16	Mulched with straw	− 20	− 6	− 21	..	− 16
17	Grass grown	− 54	− 81	− 57	..	− 63
18	Ground hardened	+ 6	+ 23	+ 50	..	+ 26
19	Weeds grown*	− 53	− 63	0	..	− 85
20	Dug near roots	− 11	+ 3	+ 31	..	+ 8
22	No phosphate	− 17	+ 28	+ 36	..	+ 16

* Compared with 56 as standard. *See* foot-note to Table 2.

TABLE 4.—PERCENTAGE INCREASE (+) OR DECREASE (−) IN THE NUMBER OF GROWING SHOOTS OF APPLE TREES CAUSED BY DIFFERENT TREATMENT—*continued.*

Plot.	Treatment.	Bramley.	Cox.	Potts.	Stirling Castle.	Mean.
23	No potash	+ 6	− 7	− 17	..	− 5
24	No nitrate	− 9	− 20	+ 12	+ 21	+ 1
27	Dunged before planting	− 30	+ 15	+ 27	..	+ 4
28	Dunged every year	− 8	+ 22	− 13	..	0
29	Ammonia instead of nitrate	− 8	− 29	− 40	..	− 26
30	Ammonia, but no potash	+ 15	0	− 2	..	+ 4
32	No manure	− 12	− 8	0	..	− 7
33	Half-dose of manure	− 12	+ 1	− 19	..	− 10
37	Minerals in spring	− 10	− 9	+ 17	..	− 1
38	„ summer	− 19	− 28	− 14	..	− 20
40	Nitrate in summer	+ 25	+ 2	+ 14	+ 10	+ 13
41	„ autumn	− 4	+ 20	+ 27	..	+ 17
42	Badly planted	+ 53	− 10	+ 15	..	+ 19
[42	„ 1895	− 5	− 14	+ 17	..	− 1]
43	Neglected and restored	− 15	− 39	− 41	..	− 32
44	Neglected	− 50	− 75	− 85	..	− 70
[44	„ 1895	− 82	− 84	− 78	..	− 81]
45	Ground not trenched	+ 70	+ 26	+ 14	..	+ 37
46	Three-feet holes	+ 38	+ 29	+ 29	..	+ 32
47	Holes with chalk bottoms	+ 60	+ 9	− 9	..	+ 20
48	Planted too high	+ 23	− 19	− 13	..	− 3
49	„ „ low	+ 43	+ 30	+ 38	..	+ 37
50	Chalk with the soil	+ 14	− 21	+ 3	..	− 1
51	Stones „	− 10	− 15	− 11	..	− 12
52	Gravel „	+ 18	− 42	− 2	..	− 9
53	Peat „	+ 94	+ 97	+ 42	..	+ 78
55	Compost	+ 34	+ 40	+ 33	+109	+ 57
56	Replanted November 1895	− 62	− 53	− 75	..	− 63
57	Planted in winter*	+ 87	+ 37	+ 28	..	+ 51
58	„ spring*	+ 23	+ 6	+ 28	..	+ 19
59	Blossoms removed	+ 71	+ 30	+ 51	+ 88	+ 60

* Compared with 56 as standard. *See* foot-note to Table 2.

Standards.

Plot.	Treatment.	Bramley.	Cox.	Prince Albert.	Mean.†
189*	Grass grown	− 37	− 48	− 10	−32 (−63)
190*	No summer shortening	− 5	− 2	+ 2	− 2 (−17)
192*	Summer shortening; no pruning.	− 8	− 17	+ 4	− 7 (− 7)
193*	No nitrate	− 12	− 15	+ 9	− 6 (+ 1)
194*	Summer pruning	− 7	− 18	− 24	−16 (−32)
196*	Neglected	− 27	− 26	− 20	−24 (−70)
197*	Nitrate in July	+ 27	+ 13	− 7	+11 (+13)
198*	Planted too low	+ 4	− 16	− 25	−12 (+37)
199*	Holes with chalk bottoms	+ 32	+ 29	+ 29	+30 (+20)
224	Weeds grown	..	..	− 14	−14 (−85)‡
225	Blossoms removed	..	..	+ 6	+ 6 (+60)

* † ‡ *See* foot-notes to Table 3.

Crops.

Although the bush apple trees bore a very satisfactory crop in 1896, it was found to be too small for purposes of accurate comparison; it was only where the differences of treatment were excessive that the effect on the crop was marked, and it is only in such instances that we need refer to the results.

The crop of each plot was divided into three grades according to size,§ and the fruits in each grade were counted, measured and weighed. So far as we can see, it seems next to impossible to obtain any satisfactory means of measuring quantities of fruit when these quantities vary much, unless the laborious method of measuring the bulk of water which they can displace be adopted: weight, number and size (or average weight of the fruits)

§ Windfalls and bruised fruits were included in the third grade last year. This should not be so for scientific purposes; the grading should be strictly according to size, unless the fruits are malformed.

promise to be more practicable. One of these data cannot be of much value when taken by itself, for the total weight of a crop and the number of fruits may be considerable, and yet, owing to the size of the fruits, the crop may be of little value: the size of the fruits is equally insignificant, unless the number of fruits is considerable. We have, therefore, deduced from the above combined data a quantity which we have termed the "value" of the crop. We find that the average weights of single fruits of the first, second and third grades of the varieties dealt with are roughly in the proportion of 4 : 2 : 1, and we assume that the value to the grower of the same weight of fruits of the three grades is in the proportion of 4 : 2 : 1,* and that, therefore, the relative values of single apples of the three grades will be in the proportion of 16 : 4 : 1; so that, if we add together the number of apples of the first grade, the quarter of the number of those of the second grade, and the sixteenth of those of the third grade, we shall get quantities representing the total relative value of the crops in different cases.

It may prove advisable to modify this method somewhat in future years, but for the present purposes it will be found sufficient. It should be pointed out that the "value" of the crop which is gathered from a tree does not necessarily measure the strain put upon the tree to produce this crop, for, according to certain analyses which have been published, imperfectly developed fruits will remove a greater relative proportion of nutritive matter than do larger and more fully-developed fruits.

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* The relative values to the grower are not identical with the relative values in the market, as the grower's expenses in marketing the crop are more or less independent of the grade.

The standard apples bore very little fruit in 1896; not sufficient for useful measurement.

Agreement between the different Methods of Examination.

The mean values obtained by the three principal methods described above are reproduced side by side in columns III., IV. and V. of Table 5.

TABLE 5.—MEAN RESULTS OBTAINED BY DIFFERENT METHODS, 1896.

Plot.	Treatment.	Leaf-size.	Growth.	No. of Shoots.	Difference between III. and IV.	Difference between IV. and V.
I.	II.	III.	IV.	V.	VI.*	VII.*
2	Cut back at end of 1st year	+ 20	+ 76	+ 16	A + 56	A′ + 60
3	Cut back; not pruned	+ 18	+ 35	− 11	A + 17	C 46
4	Not cut back nor pruned	− 27	− 76	− 53	A + 49	A + 23
5	Pruning only, moderate	..	− 12	− 17	..	A − 5
6	„ hard	..	− 10	− 22	..	A − 12
7	Summer shortening only, moderate.	..	− 20	− 7	..	A + 13
8	Summer shortening only, hard.	..	− 64	− 33	..	A′ + 31
9	Summer pruning	− 9	− 63	− 32	A + 54	A′ + 31
14	Root pruned	− 39	− 91	− 62	A + 52	A′ + 29
15	Lifted	..	− 22	− 26	..	A − 4
16	Mulched with straw	..	− 21	− 16	..	A + 5
17	Grass grown	− 35	− 87	− 63	A + 42	A + 24
18	Ground hardened	− 17	+ 11	+ 26	C 28	A − 15
19	Weeds grown	− 44	− 85	− 72	A + 41	A + 13
20	Dug near roots	− 8	+ 2	+ 8	B 10	B − 6
22	No phosphate	− 6	− 3	+ 16	B − 3	A 19
23	No potash	+ 1	− 2	− 5	B 3	B − 3
24	No nitrate	0	+ 4	+ 1	B 4	B + 3

* The sign + signifies that the effect as measured by the growth is greater than that measured by the other feature examined; otherwise the differences are algebraical.

Table 5.—Mean Results obtained by different Methods, 1896—*continued.*

Plot.	Treatment.	Leaf-size.	Growth.	No. of Shoots.	Difference between III. and IV.	Difference between IV. and V.
I.	II.	III.	IV.	V.	VI.†	VII.†
27	Dunged before planting	0	− 5	+ 4	B 5	B 9
28	„ every year	..	+ 4	0	..	B 4
29	Ammonia instead of nitrate	..	− 11	− 26	..	A − 13
30	Ammonia, but no potash	..	− 4	+ 4	..	B 8
32	No manure	− 23	− 11	− 7	A − 12	B + 4
33	Half-dose of manure	− 11	− 13	− 10	A + 2	A + 3
37	Minerals in spring	..	+ 11	− 1	..	B 12
38	„ summer	..	− 9	− 20	..	A − 11
40	Nitrate in summer	− 8	+ 47	+ 13	A′ 55	A′ + 34
41	„ autumn	..	+ 50	+ 17	..	A′ + 33
42	Badly planted	− 25	+ 31	+ 19	C 56	A + 12
43	Neglected and restored	− 10	− 20	− 32	A + 10	A − 12
44	Neglected	− 56	− 94	− 70	A + 38	A + 24
45	Ground not trenched	− 17	+ 2*	+ 37	A′ 19	C − 35
46	Three-feet holes	+ 8	+ 41*	+ 32	A + 33	A + 9
47	Holes with chalk bottoms	..	+ 17*	+ 20	..	A − 3
48	Planted too high	− 7	− 13*	− 3	B 6	B + 10
49	„ low	− 7	+ 36*	+ 37	A′ 43	A − 1
50	Chalk with soil	..	− 9*	− 1	..	B + 8
51	Stones „	..	− 17*	− 12	..	A + 5
52	Gravel „	..	− 38*	− 9	..	A′ + 29
53	Peat „	+ 4	+ 68	+ 78	A′ + 64	A − 10
55	Compost	+ 16	+ 75	+ 57	A + 59	A + 18
56	Replanted November 1895	− 53	− 92	− 63	A + 39	A′ + 29
57	Planted in winter	+ 4	+ 58	+ 51	A′ + 54	A + 7
58	„ spring	+ 7	+ 13	+ 19	B + 6	A − 6
59	Blossoms removed	− 2	+ 47	+ 60	A′ 49	A − 13

* Bramley omitted.

† The sign + signifies that the effect as measured by the growth is greater than that measured by the other feature examined; otherwise the difference is algebraical.

We may first of all compare together the results from the growth and from the number of shoots. These two features are, as has already been mentioned, not altogether independent of each other, and a considerable amount of concordance might naturally be expected; but the agreement will be found to be much better than what would necessarily follow merely from this partial dependence. A comparison of the two sets of figures shows, in the first place, that the alteration in the growth produced by different treatment is greater than that produced in the number of shoots, the alteration in the former being on the average 8 per cent. larger. The individual differences in the percentage alteration measured by the two methods are given in column VII. The differences are algebraical, and a + sign preceding them indicates that the alteration as measured by the growth is greater than that measured by the number of shoots, and *vice versâ*, whether the alteration itself is an increase (+) or a decrease (−). In cases where one property shows an increase and the other a decrease, no sign can be prefixed.

These differences we have divided into four classes—first, those marked A, where the treatment has produced a measurable effect (an alteration of 10 or 12 per cent.), and where the agreement of the two properties is as good as could reasonably be expected, the differences between the numbers being less than three times the mean difference, *i.e.*, differences between + 24 and − 16; of these there are 25 instances. Secondly, those marked A′, where the differences, although of the same character as the majority, *i.e.*, being +, and indicating that the alteration in growth is greater than that in the number of shoots, are, as to magnitude, rather large, being over 24: of these there are eight

a p. 5387.

instances. Thirdly, those marked B, where the results according to both properties, show no appreciable effect.* Of these there are 10 instances, and they are, of course, equally with A, instances of agreement between the two methods. Lastly, those marked C, in which the concordance cannot be regarded as satisfactory. Of these there are only two instances. In one, No. 3, the effect measured is considerable according to the growth, but scarcely so according to the number of shoots; in the other, No. 45, it is the number of shoots, and not the growth, which shows a measurable effect.

To sum up. Out of 45 cases, there are 35 where the agreement of the two properties is very good, 8 where it is fairly good, and only 2 where it is not good. Such an amount of agreement must, we think, be accepted as most satisfactory, and we may feel confident that in drawing any conclusions from the results obtained by one method only, we shall in future be as safe as if both methods had been used.

Still more important, however, is the comparison between the measurements of leaf-size and growth, for here the results are, so far as the measurements are concerned, quite independent of each other. Column VI.

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* It is, of course, not possible to define exactly what is a measurable effect and what is not, nor to draw an exact line between the A and B class. If all the properties indicate a change in the same direction, we may take it that the change has been measurable, although it may be rather smaller in amount than in other cases, where it has been taken to be negligible owing to the properties having given opposite and, therefore, uncertain indications. In the same way it is impossible to draw a correct line between the A and A′ classes, since a difference of, say, 30, where the individual numbers are 60 and 90, is relatively much less than a difference of, say, 10, where the individual numbers are 20 and 30. Expressing the differences as percentages of the individual numbers would obviate this difficulty, but it would land us in greater ones, owing to the relative magnitude of the experimental error of the individual numbers being greater when these numbers are small.

gives the differences between these two sets of results, prefixed by signs which have the same significance as those in column VII. The letters used here have also nearly the same meaning as in the previous case. Those marked B are instances in which both features show no appreciable effect from the treatment adopted, and where, therefore, the results are fully concordant. Of these there are seven instances. Those marked A are cases where the effect has been appreciable by both methods, and is in the same direction, and where, therefore, the results may be regarded as concordant. Of these there are 14 instances, and, in every case but one, the differences show that the effect produced on the growth is greater than that produced on the leaf-size, in 10 out of the 14 cases the excess being very considerable. Further, it may be noticed that the actual value for this excess is an approximately constant quantity, the constancy, though certainly not absolute, being too evident to be attributable to mere accident. The differences in these 10 cases are—

$$+ 56, + 49, + 54, + 52, + 42, + 41, + 38, + 33, \quad 59$$
$$\text{and } + 39.$$

In the four other of the instances marked A the differences are of a totally different order of magnitude, being—

$$+ 17, - 12, + 2 \text{ and } + 10.$$

The instances marked A′ are those in which the effect has been measurable in one case, but not in the other. Of these there are six, and a critical examination of them must lead to the conclusion that they are quite as satisfactory in showing concordance between the two methods as are those marked A, for in five out of the

six cases the differences are not only in the same direction (growth showing the greatest effect), but in actual magnitude they are approximately constant, and are, moreover, closely similar to those observed in the A cases. They are—

(+) 55, (+) 43, + 64, + 54 and (+) 49,*

the only exceptional case being, as with the A instances, a difference of a totally different order of magnitude, namely, 15.

Thus, out of 29 cases available, we may count 22 as showing the most satisfactory concordance (those marked B, and those of the ones marked A or A′ where the differences are large), five as showing concordance of a less satisfactory character, while in two cases only, those marked C, are the results discordant.

An agreement of this nature is better than could have been expected, even if we had had (which was not the case) every reason to believe that the two features examined must necessarily be affected in the same way by the same treatment, and that any discrepancies must be due to mere errors of experimentation. That the examination of these independent features leads, with a few possible exceptions, to the same result, there can now be little doubt, and the importance of such a conclusion can scarcely be over-rated, for, had it been otherwise, no confidence could have been attached to any method of examination, and the scientific measurement of the effect of different treatment on trees would, if

* Where the + sign has been put in parentheses, the leaf-size showed an effect in the opposite direction to the growth, but, as it was inappreciable in amount, we may legitimately represent the effect measured by the growth as being the greater, in which signification we have used the + sign in the other cases.

practicable at all, have had to be of a most laborious and exhaustive nature.

With another year's growth on the trees the measurement of that growth would entail an almost prohibitive amount of labour, and it is, therefore, of the greatest importance to have established the fact that leaf-measurement may be substituted for it.

The size of the leaf is not so responsive to differences of condition as is the growth, but, on the other hand, the results obtained from it are more concordant amongst themselves, and the variation in individual trees is much less. Also, by substituting weighings for measurements in future years it will be possible to include a larger number of leaves in the investigation, and thus to increase the accuracy of the method, without any corresponding increase in labour.

The approximate constancy of the difference between the effect on the growth of the wood and that of the leaf is certainly remarkable. It can only be interpreted as indicating that any alteration in conditions affects the wood growth first, and that it is only after that has been so far affected as to be about 50 per cent. in advance of or behind the normally-treated trees that the leaf development begins to be affected: beyond that point any further alteration affects the leaf and the wood-growth almost equally.

In the few cases where the leaves have been weighed the results are in agreement with the leaf-size, in showing that a diminution in the latter is accompanied by a diminution in the weight per given area, the leaf being thinner as well as smaller, though the percentage reduction in substance is naturally less than that in the area.

The plots which were thus investigated gave the following results :—

PERCENTAGE ALTERATION IN WEIGHT PER SQUARE CENTIMETRE OF LEAVES, 1895.

Plot.	Treatment.	Bramley.	Cox.	Potts.	Mean.
4	Not cut back nor pruned	− 2	− 0·7	− 10	− 4 (−24)
42	Badly planted - -	− 5	− 1	− 11	− 6 (−34)
44	Badly planted and neglected.	− 23	− 14	− 15	− 17 (−75)

The values in parentheses are the corresponding ones for the leaf-size. The same order is observed in the two cases.

Where the number of leaves on the trees has been counted, and the total leaf-area of the tree thus determined, the results afford further confirmation of those obtained from the other measurements : they will, however, be more conveniently discussed when describing the particular cases where the method has been employed. From what has been said as to the weight of the leaves, it follows that an alteration in the total leaf-weight per tree will be greater than that of the total leaf-surface.

A cursory examination of the tables (2, 3 and 4) containing the details of the results with different varieties, is sufficient to show that different methods of treatment affect different varieties to different extents, and sometimes even in an opposite direction. Thus, with the leaf-size, the total probable experimental error of the results from each set of six trees is, as has been stated, less than $\pm$ 5 per cent. ; but a glance at Table 2 will show that

differences much greater than this often occur between the results with the three varieties. This is only what might naturally be expected.

Having now established the validity of the methods employed, we will discuss the results obtained under the different treatment adopted in individual cases. Before doing so, however, it may not be superfluous to say a few words on the subject of experimental results and experimental errors, since those who have not given attention to such matters may possibly misinterpret som of our results.

In horticulture, more, perhaps, than in any other study, do we constantly find isolated and imperfect observations brought forward with the confidence which should attach only to rigorous and exhaustive experiments. A man who has obtained satisfactory results by treating in a certain way a particular tree, or a particular orchard, promptly advocates such treatment as being superior to all others; and exceptional instances of individual success are continually being adduced, as if they were normal results which anyone might expect. But, to justify any conclusions as to some particular method of treatment, other methods should, obviously, have been tried on precisely similar trees under otherwise precisely similar conditions, and we hardly ever find that even a rudimentary attempt to do this has been made. It is true that an absolutely rigorous experiment in horticulture is impossible: precise similarity in conditions of even two trees is unattainable. We may secure, without difficulty, a similarity as regards atmospheric conditions, and, in a less perfect degree, a similarity of soil; but, as regards the important factor of a strict similarity in original nature and vigour of the two trees, we are

helpless; and if we happen to apply the worse method of treatment to the tree which is by nature the stronger, the ill-effects of the treatment may be entirely masked by the innate vigour of the individual, and we shall thereby be led to very wrong conclusions. The only possible way to guard against such an occurrence is by increasing the number of trees in the experiment. We thereby reduce the "experimental error," and render it possible to feel certain as to the measurement of differences, which, if we were dealing with individuals, would be insignificant. It may often happen, as it does in every branch of science, that the error of a single observation is far greater than the total differences to be measured, and yet, if the observations are repeated often enough, we may feel quite confident as to the correctness of our results; and, conversely, the results of carefully-conducted experiments on a large number of trees cannot be negatived by any casual observations made on isolated individuals.

By way of illustration, we may take the growth-measurements of plot 15, where the effect of the treatment adopted caused, on the average, a loss of 21 per cent. of growth as compared with normally-treated trees. The loss varies in amount with the three different varieties examined, but, as it is shown consistently by all of them, there can be no doubt as to its reality. Looking, however, at the results with the individual trees, it will be found that the loss is by no means apparent in all cases, there being several instances (6 out of 18) where the innate vigour of the tree has resulted in a freer growth than in the normal trees with which they are compared. The percentage loss (−) or gain (+) shown by the separate trees is as follows:—

	Bramley.		Cox.		Potts.	
	Length.	Increase or Decrease.	Length.	Increase or Decrease.	Length.	Increase or Decrease.
	c.m.	Per cent.	c.m.	Per cent.	c.m.	Per cent.
1st tree	501	+ 8	715	− 20	239	− 14
2nd „	150	− 68	1,119	+ 25	304	+ 10
3rd „	262	− 44	301	− 65	263	− 5
4th „	102	− 78	877	− 2	216	− 22
5th „	525	+ 13	1,350	+ 46	131	− 53
6th „	473	+ 2	335	− 62	143	− 48
Mean	335	− 28	783	− 13	216	− 22
Probable error of measurement of one tree.	± 158	± 34	± 269	± 30	± 44	± 16
Probable error of mean from six trees.	± 65	± 14	± 107	± 12	± 19	± 7

Mean result from all three varieties = − 21 per cent.; probable error ± 6·3 per cent.

Taking Bramley, the average loss shown is 28 per cent., but the probable error of the result with one tree (calculated in the manner indicated on p. 61) is ± 34, *i.e.*, greater than the quantity to be measured, so that any observation based on a single tree would be quite useless: but, by taking the mean from six trees, we reduce the probable error to ± 14, and, as this is only half the quantity measured, our measurements will possess some value. With Cox the probable error of the result, even of the mean from the six trees, is barely less than the quantity measured, so that the measurements in this case possess little or no value; whereas with Potts the variation is much smaller, and some weight might be attached to the measurement even of one tree, the probable error of such a measurement being ± 16, whereas the differences measured average 22.

By taking the mean of the three mean values with each variety, we still further reduce the probable error

of the result, this error now becoming only ± 6·3 per cent., or less than one-third of the quantity measured.

In the above illustration we have, for the sake of simplicity, assumed that the error in the measurement of the trees in the plot in question was the only error existing. This is not so when we are comparing the measurements with those of normally-treated trees, for there will be a similar error in these latter measurements also; but, inasmuch as the normal values are dependent on the results from a number of different plots, as already explained on p. 61, the error in them will be proportionately smaller.

Results of different Methods of Treatment.

Results of Neglect.

In the neglected plots the ground was not trenched, the trees were carelessly planted without having their roots trimmed, the weeds were allowed to grow (after being removed once), and no manure was applied. As regards the latter item, however, the trees were on the same footing in 1895 as the other plots, and, since in the following season of drought, manure seems to have had no effect, as will be seen later on, the effect produced must be attributed solely to ill-treatment in other respects. That the carelessness of the planting was by no means exaggerated is shown by the results with 42, in which, although similarly planted, the trees were to all outward appearances as healthy as the normal ones, and revealed the effects of bad planting only when examined

by careful measurements; indeed, we fear that we have not attained the standard of neglect in which many would-be horticulturists indulge.* Yet the loss of vigour as measured by the leaf-size amounted to 75 per cent. in the first year, and, though the trees had recuperated somewhat by the second year, they were then still 56 per cent. below the normal. At the end of the first year eight out of the eighteen trees were entered as practically dead, though six out of these eight recovered in the following year sufficiently to throw out a branch or two near the stock.

The values for all three varieties were very concordant in both years, the maximum differences being only 5 per cent.

The loss of growth in 1895 amounted to as much as 93 per cent., and was practically the same (94) at the end of the next year. The number of leaves on the trees were also considerably below the normal, so that the total leaf-area of the trees in 1895 showed a loss of 84 per cent. (the data are given below in Table 6); and, when the total leaf-weight is taken, the loss amounted to 92 per cent., or, in other words, the weight of leaves borne by these trees is only one-thirteenth of that borne by the normally-treated trees.

The crop of fruit yielded by the neglected trees in 1896 was practically *nil*, being only 5 per cent. of that of normally-treated ones.

These values will give some idea of the importance of treating trees properly, and not leaving them to look after themselves, as is so often done. It is only fair, however, to remember that the two summers through which our trees

* The trees had, for instance, been protected from insect pests for the sake of their neighbours.

have passed have been exceptionally trying ones, and that the ill-effects might, perhaps, not have been so marked in wetter seasons.

We give below a reproduction of photographs of one of the neglected Cox's Orange, and one of the corresponding normal trees in 1895, and on p. 100, Figs. 12 and 14, will be found similar instances in the case of standard trees. The staff near the tree is marked off into feet. Similar photographs of the other varieties showed the difference in quite as striking a manner.

Of the various items which constitute the "neglect" in this case, we find, taking the second year's leaf-measurements, that—

Not trenching the ground causes	17	per cent.	loss.
Careless planting	25	„	„
Growth of weeds	44*	„	„
Absence of manure	23	„	„

These numbers, when added together, amount to considerably more than the 56 per cent. observed; but it need scarcely be pointed out that various items of neglect combined would not necessarily produce a loss in the leaf-size (even if this were directly proportional to the vigour of the tree) identical with the sum of those produced by the items taken singly.†

The prompt response of young trees to proper culture, even after serious neglect, is illustrated by plot 43. The trees in it were carelessly planted and neglected, like those in 44, and showed the same loss of vigour; but after

* Value applicable to the first year after planting; that for the second year is probably smaller, as explained below.

† Not staking the trees is another item, which probably has a considerable effect in our soil, but its effect was not measured separately.

Fig. 7.

COX'S ORANGE PIPPIN.—Plot 44.

Carelessly planted and neglected. 1895.

Fig. 8.

COX'S ORANGE PIPPIN.—Plot 39.

Normal. 1895.

the first year they were tended, the ground was cleaned, and the normal dressing of manure applied. The result was, that in the following season, instead of showing a loss of 56 per cent, like their neglected neighbours, they were only 10 per cent. behind the normal trees. The loss of growth was in a similar manner reduced from 94 to 20 per cent. This, it may be objected, is less than the deficit shown by trees badly planted (No. 42), and by trees planted in untrenched ground (No. 45), both of which unfavourable conditions still applied to the restored trees: but it must be remembered that these trees had lost many of their branches by the previous year's ill-treatment, and that all the energy of the roots was concentrated on the few remaining ones. The total leaf-area of the trees, had this been measured, would have given much less favourable values. The total crop of the trees was only 3 per cent. of that of the normally-treated trees—a quantity even smaller than that of the permanently neglected trees (No. 44), though this latter fact has no significance, since it is explained by the greater part of the fruit-buds, which had formed on the trees in plot 43 while neglected in 1894, having been removed when the branches were cut back as a preliminary step to restoration.

In 1895 the total leaf-area of the neglected trees was determined, as also that of the badly-planted trees. In 1896 this was done also with other badly-planted trees, for, owing to certain results obtained with the measurement of growth, it was thought desirable to repeat the experiments. The trees for this repetition were planted in 1895, and measured in 1896. They form plots 651 and 650, the normal plots, which were planted at the same time for comparison with them, being 643 and 632. These various results are collected in Table 6.

Table 6.—Effect of Bad Planting and of General Neglect.

Plot.	Alteration in Leaf-size.			Alteration in Total Leaf-area.			Alteration in Wood-growth.		
	1st Year after Planting.		2nd Year.	1st Year after Planting.		2nd Year.	1st Year after Planting.		2nd Year.
	1895.	1896.	1896.	1895.	1896.	1896.	1895.	1896.	1896.
Bad Planting only.									
Dwarfs.									
42. Bramley	− 38	..	− 22	− 51	..	− 17	+ 15	..	+ 63*
651. „	..	− 50	..	..	− 66	..	..	− 34	..
42. Cox	− 31	..	− 35	− 36	..	− 52	− 12	..	− 10
650. „	..	− 32	..	..	− 10	..	..	+ 26	..
42. Potts	− 32	..	− 18	− 40	..	− 20	+ 15	..	+ 39
Means	− 34	− 41	− 25	− 42	− 38	− 30	+ 6	− 4	+ 31
	− 32			− 37			+ 11		
Bad Planting and General Neglect.									
Dwarfs.									
44. Bramley	− 77	..	− 53	− 86	..	..	− 95	..	− 89
44. Cox	− 72	..	− 58	− 77	..	..	− 95	..	− 97
44. Potts	− 77	..	− 58	− 90	..	..	− 90	..	− 96
Means	− 75	..	− 56	− 84	..	..	− 93	..	− 94
Bad Planting and Partial† Neglect.									
Standards.									
196. Bramley	..	..	− 37	..	..	..	..	..	− 70
208. Cox	..	..	− 27	..	..	..	..	..	− 61
220. Lane's	..	..	− 24	..	..	..	..	..	− 55
	..	..	− 28	..	..	..	..	..	− 62

* Probably too high.

† *i.e.*, the trees were staked, but in other respects neglected.

As regards leaf-size and also total leaf area, the agreement of the results of the original (No. 42) with repetition experiments (Nos. 651 and 650) is very good, and the values obtained with the same plots in successive seasons show that the trees have regained with time some of the ground lost. Looking at the different measurements of the same plots, we see that the loss of total leaf-area is greater than that of leaf-size, or, in other words, that the bad treatment adopted has reduced the number as well as the size of the leaves.

As regards the wood-growth, the results of the badly-planted plots are anomalous and perplexing. They are not concordant in themselves, and show on the whole an increase, instead of decrease, as compared with the normal plots. The anomaly in the case of plot 42 was at first attributed to a shelter hedge of crab-apples, which had been planted at the same time as the trees, and at a distance of 8 feet from them; but, that this offers no explanation, is shown by similar results having been obtained in the case of the repetition experiments, Nos. 651 and 650. The mean increase shown is 11 per cent., but if we omit the results with Bramley in 1896, which are undoubtedly too high, the increase is reduced to 6 per cent. The measurement of the number of shoots in No. 42 gave very similar values, namely—

——	Bramley.	Cox.	Potts.	Mean.
1895	− 5	− 14	+ 17	− 1
1896	+ 53	− 10	+ 15	+ 19

It is intelligible that the effects of careless planting, and of not trimming the roots of the trees before they were planted, might vary considerably in different cases,

and it is also intelligible that no ill-effects might be noticed till some years after the planting; but the measurement of the leaf-size and number of leaves (total leaf-area) shows that the ill-effects have been very considerable, and this renders the non-appearance of any similar ill-effects on the wood-growth very perplexing, especially as the effect on the wood-growth is in nearly every other case greater than that on the leaf-size.

To ascertain whether the growth in these plots had been abnormally thin and weedy, the prunings from them were weighed and measured, and the results compared with those from the normal plot nearest to them, No. 39; the Cox's Orange plot No. 650 was treated in the same way, but Bramley No. 651 showed too small a growth to admit of any pruning. These measurements give the average weight per unit length of the wood removed, and the percentage excess or deficit over that from the corresponding normal plots was as follows:—

Bramley, No.	42	— 1·3	per cent.
Cox, „	42	— 4·5	„
„ „	650	— 7·7	„
Potts, „	42	+11·0	„
Mean		— 0·6	„

Thus, although three out of the four plots show that the shoots of the badly-planted trees were more weedy than those of the normal ones, the differences are very small, and in the mean from all four plots it is inappreciable.

Probably the true explanation of these results is connected with the fact that the crop of fruit yielded by the badly-planted trees was notably smaller than that of the normally-treated trees, the deficit being

about 50 per cent. It is probable that this deficit, whether accidental or due to the bad planting, may have been the cause of the growth being in excess of what might have been expected, the vigour which the trees would normally have expended in developing fruit being diverted to the production of wood. This explanation is rendered all the more probable by the results obtained in 59, for here fruiting was prevented by removing the blossoms, and the result was a considerable increase in the growth of wood, but no alteration in the leaf-size—a precisely similar effect to that observed in the case of the badly-planted trees: but why bad planting should cause a diminution of the crop (if this is the true explanation), is by no means clear, and the matter is one which requires further investigation.

It is noticeable that the results with trees in their first year after planting are practically the same both in 1895 and 1896. The spring and summer of these two years, it is true, were very similar as regards drought, but the winters were very different, and the latter year was far more disastrous to recently-planted trees than the former. This tends to show that comparative results of different methods of treatment would in many cases be independent of the nature of the season.

Effect of Grass round Trees.

The effect of growing grass round trees is amongst the most striking and practically useful of our results. The grass sown was a mixture recommended for orchards on heavy land.* It was sown in the spring of 1895,

* The composition of the mixture was, 1 lb. *Alopecurus pratensis*, 2 lbs. *Cynosurus cristatus*, 5 lbs. *Dactylis glomerata*, 3 lbs. *Festuca pratensis*, 3 lbs. *Festuca rubra*, 2 lbs. *Festuca duriuscula*, 1 lb. *Phleum pratense*, 1 lb. *Poa nemoralis sempervirens*, 3 lbs. *Italian* and 5 lbs. *Pacey* (total = 26 lbs.) per acre.

but, owing to the drought, did not come up till late in the year, and its effect must have been the less in consequence, yet in the second year after planting it had produced a reduction of 35 per cent. in the size of the leaf with the dwarfs, and 41 per cent. with the standards, while the reduction in growth of wood had amounted to no less than 87 per cent. with the dwarfs, and 74 per cent. with the standards. With the dwarfs there was also a reduction of the crop of fruit, amounting to 71 per cent. in weight and 82 per cent. in value; and the fact of the value being less than the weight shows that there was a deterioration of the size, as well as quantity, of the fruit.

Of particular interest is the comparison of the effect of weeds with that of grass, since the ill-effect of the latter seems to be considerably greater than that of the former. This is not shown accurately by a comparison of plots 17 and 19, since they are not strictly comparable, the latter having been replanted at the close of 1895. In the case of standards, however, the values are comparable, and, although in the only plot (No. 224) where weeds were grown without other bad treatment, the leaf-size was reduced only 1 per cent. less than it was by the grass, still the growth of wood was affected by the weeds to the extent of only 43 per cent., whereas the grass produced a reduction of 74 per cent.; and, indeed, comparing the result of the combined ill-effects of weeds, bad planting and absence of manure, we find that these are less than the ill-effect of grass only; the latter reduces the leaf-size by 41 per cent., whereas weeds and neglect reduce it by 28 per cent., and the reduction in the wood-growth is of a similar character, namely, 74 per cent. by grass, and 62 per cent. by weeds and neglect.

FIG. 9.

POTTS' SEEDLING.—PLOT 17.

Properly planted and tended, except that grass is grown round the tree. 1896.

FIG. 10.

POTTS' SEEDLING.—PLOT 40.

Normal. 1896.

The effect of grass round trees is of such great practical importance that we give some reproductions of photographs, which will illustrate it in two cases. The trees which were photographed were selected as being average representatives of the trees in the respective plots, and there was little or nothing to choose between the different varieties for the clearness with which they showed the effect. It may also be seen from the photographs, especially from those of the standards, which were all taken on the same day, that the leaves of the grass-grown trees were much lighter in colour than those of the other trees, and were shed earlier.

That grass round trees should have a worse effect than weeds is perhaps to be expected when we remember that grasses are perennial, and that most weeds are annuals, the latter being, therefore, operative during only a limited period of the year. As the varieties of weeds are very numerous, however, their action must also be very diverse, and we must not accept the present results as being typical of weeds in every case. It is interesting to note how one weed will oust another. In 1895 the May-weed (*Matricaria inodora*) was by far the predominant weed in our plots (as may be seen from fig. 7 facing p. 92); there was also a considerable undergrowth of the common knot-weed (*Polygonum aviculare*), with some chick-weed (*Stellaria media*) and a few thistles of various kinds. In 1896 the *Matricaria* was greatly reduced in quantity, the *Polygonum* was fairly abundant, and a series of grasses, chiefly species of *Agrostis*, *Bromus*, *Poa*, *Avena*, and *Triticum*, had taken possession of the ground.

The ways in which grass militates against the welfare of trees planted in it are several. It, no doubt, absorbs

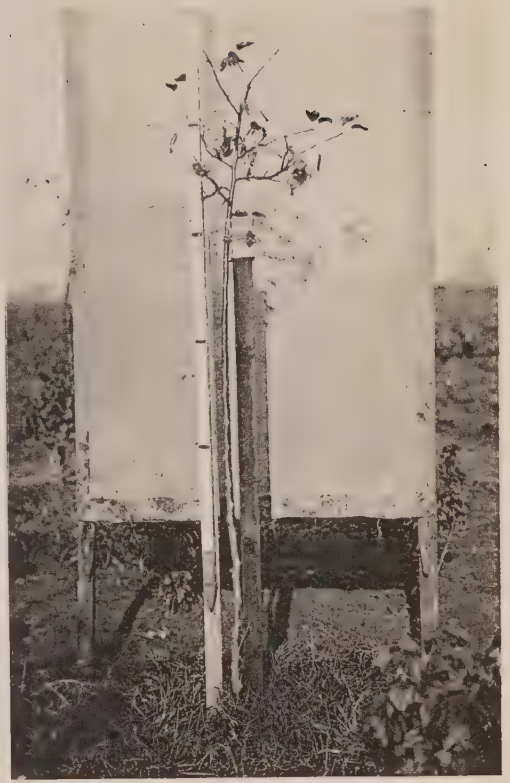
in part the dressing of manure which would otherwise benefit the tree, although in our experiments the plant food is not permanently removed from the soil, as the grass is cut and left on the plots, and during the past seasons the manures have, owing to the drought, had no effect on the results: it prevents the hoeing of the ground, and the consequent aëration of the soil; and, lastly, it promotes evaporation from the soil, both directly from the leaves of the weed, and indirectly by preventing tillage, which fills up the cracks through which the moisture of the soil escapes.

It is to the last-mentioned action that we are inclined to attribute the greater part of the ill-effects of grass during the past two seasons. Some comparative experiments of Greaves,* extending over 14 years, showed that in a sandy ground the average annual evaporation from the soil when turfed was 18·1 inches, whereas from the exposed soil it was only 4·2 inches, or less than one-quarter as much; and in a dry season, such as those of the last two years, a similar increase in the evaporation would probably reduce the water in the soil below the limit at which trees begin to suffer or wilt. If this is correct, the effect of grass in a wetter season would be less marked than we have found it.

The effect of the hardening of the soil, which grass promotes through absence of tillage, has been measured separately in No. 18, and the results here show an average loss in leaf-size of 17 per cent. This value is probably lower than it should be, since, up to the present, the weeds in the plot have been removed by the hoe instead of being pulled as they should have been, and the loosened ground made firm afterwards.

* *See* Lawes, Gilbert and Warrington on the Rain and Drainage Water at Rothamsted (Journ. Royal Agric. Soc. 1881, p. 325).

FIG. 11.



LANE S PRINCE ALBERT.—PLOT 213.

Properly planted and tended, except that grass is grown round the roots. 1896.

FIG. 12.

LANE'S PRINCE ALBERT.—PLOT 220.

Carelessly planted in untrenched ground, and neglected, except as regards staking. 1896.

FIG. 13.

LANE'S PRINCE ALBERT.—PLOT 224.

Properly planted and tended, except that weeds are allowed to grow. 1896.

FIG. 14.

LANE'S PRINCE ALBERT.—PLOT 215.

Normal. 1896.

It is possible that the trees planted in grass may, as appears to be happening in other cases, recover after a few years part of their lost vigour, and it is possible, also, that the sowing of grass round older and well-established trees might have but a small effect on them; but, as regards newly-planted trees, the present results can leave no doubt but that grass round the roots is, with the exception of total general neglect, the most disastrous method of treatment which can be adopted, at any rate in a dry season, and, even if it lead to no other ill-effects, must result in a retardation of growth equivalent to several years of the trees' lifetime, with a corresponding loss of time and money.

Cutting back after Planting.

The question as to whether a tree should be cut back soon after it has been transplanted, or whether it should be left for a season before this operation is performed, is one of the vexed points, on which even the best horticulturists differ. Though our experiments cannot be said to have settled the question at present, we believe that they throw some interesting light on the matter.

The theory of the subject is simple enough, but does not indicate what the correct practice should be. The roots during transplanting become injured, and part of them are removed; they are, therefore, no longer sufficient to supply food to the full complement of branches, and these must consequently be reduced, so as to become proportioned to the reduced roots: but, on the other hand, in order to form new roots, the branches should be left intact, for it is in them, and especially in the tips of the shoots, that the carbo-hydrates are manufactured which build up the roots. To meet the difficulty

Sorauer ("Treatise on the Physiology of Plants," p. 84) advocates that some of the branches should be cut back, and others left intact; but this, like most half-measures, would appear to be the worst course, and will scarcely recommend itself to horticulturists, who well know the importance of getting a well-balanced tree.

So far as not subjecting a tree to *any* cutting back or pruning goes, there is probably no diversity of opinion. Under such treatment only the buds at the ends of the shoots develop, and we get long, weak branches, which are bent down or broken by a weight of poor fruit at their extremities. A photograph of a tree of Cox's Orange Pippin in plot 4, which was treated in this way, forms a typical illustration of what is only too often seen in farmers' orchards. The leaf-measurement of this plot (taking all three varieties) showed a loss of 24 per cent. in size the first year and 27 per cent. the second year; while the total leaf-area in the first year showed a mean diminution of 15 per cent., the values with Bramley, Cox and Potts being 29, 5 and 10 per cent. respectively (*see* Table 7, p. 106). Now, these values for the first year will apply equally to trees which were cut back subsequently at the end of the first year, but later measurements show that we should not have been justified in concluding from this fact only that such a practice (cutting back at the end of the first year) was wrong, for when we come to the second year we find (plot 2, Table 2) that this loss of 24 per cent. has been obliterated, and that the leaf-size shows an actual increase of 20 per cent. above those trees which were cut back on planting (normal treatment).

The growth-measurements (Table 3) afford evidence of a precisely similar character. The absence of cutting

FIG. 15.

COX'S ORANGE PIPPIN.—PLOT 4.

Not cut back nor pruned. 1896.

FIG. 16.

COX'S ORANGE PIPPIN.—PLOT 1.

Normal. 1896.

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back on planting reduces the growth during the first year by 83 per cent., but, if the tree is then cut back, the growth during the second season is found to be in excess of the normal by 76 per cent.

One explanation which suggested itself was, that this result was due only indirectly to the delay in the cutting back, and that in another season other results might have been obtained. When the trees are not cut back, it is chiefly the buds near the ends of the branches which start, those near the stem remaining dormant, and forming neither shoots nor fruit-spurs. On cutting back after the end of the first season, the fruit-spurs on the ends of the branches are removed, and the dormant buds are forced into growth, whereas in a tree which has been cut back on planting, it is only the new wood which is removed at the subsequent pruning, and the fruit-spurs, being on the older wood, are left. Hence, trees when cut back on planting would in a season favourable to fruiting, such as was 1896, bear much more fruit than those cut back after the first season; and, as vigour of growth generally accompanies absence of fruitfulness in young trees, the increased size of the leaves might be thus accounted for. That the trees not cut back till the end of the first year bore far less fruit than the others is certain: the deficiency was 82 per cent. taking weights, and 87 per cent. taking values; but that this was not the reason for the increase in leaf-size is rendered probable by the results in plot 59. Here all the blossoms were removed, and the fruit crop was consequently *nil*, yet, although the growth was increased,* the leaf-size was quite unaltered,

* The increase in growth produced by removing the blossoms was 47 per cent.; in the case of the standards it was less (22 per cent.), as might naturally be expected, since the standards in all cases bore very little fruit.

the trees showing on the average a decrease of only 2 per cent. as compared with the normal ones.

On looking at the results with plot 3, we find another unexpected fact, which, we believe, throws some light on the subject. Here the trees, though cut back on planting, were not subsequently pruned, and we find that they also show an increase of leaf-size—18 per cent., practically the same as the trees cut back at the end of the first year. Now, these two plots are similar in so far that the trees in them have been subjected to cutting once only in the first two years after planting, whereas those in the normal plots have been subjected to two cuttings—a cutting back on planting, and a pruning in autumn (without counting the summer shortening in 1896,* which had been done on both plots alike); so that this one application of the knife during the first two years, at whatever period it occurs, produces better results than two applications, although the absence of any application at all is more disastrous than the two applications (plot 4): *i.e.*, an amount of cutting intermediate between the two extremes is the most beneficial.

Now, as has been mentioned, the roots feed the branches, and the branches feed the roots, and it is reasonable to conclude that a tree will be in the most healthy condition when its various parts are properly proportioned to each other. The loss of roots entailed by transplanting required some curtailment of branches, but the one cutting in the first two years was sufficient for the purpose, and the two cuttings were too much, upsetting the balance in the opposite direction. In support of this explanation, we find that in plot 9, where

* No summer shortening was done in 1895, as there was not sufficient growth.

summer pruning in addition to autumn pruning was adopted, and where, therefore, there had been rather more cutting away than in the normal plots, there is a further loss of leaf-size, amounting to 9 per cent. over that in the normal plots.

If these facts, and the explanation which we offer of them, are established—and we must wait for further results before considering them to be so—the amount of cutting back should be proportioned as closely as possible to the amount of injury sustained in transplanting; and we can easily understand how a practice which may be correctly adopted by nurserymen in transplanting trees in their own nursery—where the trees are often replanted at once in the same soil,—may be very different from that which should be adopted by horticulturists, when planting trees which have suffered from a long journey, and are being planted in a soil to which they are not accustomed. In illustration of this point, we may cite the results with plots 14 and 56, in both of which the trees were lifted and replanted in 1895, but in 14 the trees, after having their roots pruned, were replanted at once, and the result was a loss of 39 per cent. of leaf-size in the following season, whereas in 56, where the trees were kept out of the ground for two days before replanting, this loss was increased to 53 per cent.

In order further to investigate the question of cutting back on planting, we have started repetition experiments with dwarf trees of Bramley and Cox, and also with dwarf William's pears on the quince, Bramley standards on the crab, and Victoria plums, there being in each case two similar plots, in one of which the trees were cut back on planting, while in the other they were cut back one year later. The trees in these plots were also weighed before planting, so that eventually

we may have another means of testing the merits of the different treatment. These trees being now in their first year after planting can only be compared with plot 4 in 1895, that is, the results refer merely to the effect of not cutting back at all. These results, which are collected in Table 7, entirely confirm our previous ones so far as bush trees are concerned.

TABLE 7.—EFFECT OF NO CUTTING BACK.

Plot.	Alteration in Leaf-size.			Alteration in Total Leaf-area.		Alteration in Wood-growth.		
	In 1st Year after Planting.		In 2nd Year.	In 1st Year.		In 1st Year.		In 2nd Year.
	1895.	1896.	1896.	1895.	1896.	1895.	1896.	1896.
DWARFS.								
4. Bramley	− 17	..	− 21	− 29	..	− 86	..	− 79
635. „	..	− 34	..	..	− 28	..	− 45	..
4. Cox	− 21	..	− 28	− 5	..	− 79	..	− 78
633. „	..	− 30	..	..	− 40	..	− 80	..
4. Potts	− 35	..	− 32	− 10	..	− 84	..	− 70
631. Williams	..	− 31	..	..	..	..	− 63	..
Means	− 24	− 32	− 27	− 15	− 33	− 83	− 63	− 76
	− 28			− 24		− 74		
STANDARDS.								
629. Bramley	..	− 35	..	..	+ 29	..	..	..
627. Victoria	..	− 55	..	..	+ 27	..	..	..
Means	..	− 45	..	..	+ 28	..	..	..

The loss of leaf-size with dwarfs is 32 per cent., against 26 per cent. as the average of the two seasons in the case of plot 4, while, as to the total leaf-area, which was also determined in this instance, the repetition experiments show a greater reduction than did plot 4 (33 against 15

per cent.), and, as to wood-growth, a somewhat smaller reduction (63 against 80 per cent).

It is noticeable, however, that in these experiments, unlike those of bad planting and general neglect, the loss of leaf-size in the first year is rather less, instead of greater, than that in the second year, also the loss of total leaf-area is, on the average, less than that of the size of the individual leaves; and, when we come to the standards, this peculiarity becomes more marked, for though the want of cutting back has caused a very large loss of leaf-size (45 per cent.), the total leaf-area is actually increased by 28 per cent. The explanation of this apparent anomaly probably is, that, in the case of standards, the trees, owing to their greater bulk, contain more food material than the dwarfs, and that in a very dry season, such as 1896, the leaves of the newly-planted trees derived their nourishment almost entirely from the stored food, and not from the ground. We propose, therefore, repeating the experiments with standards another season. It may be pointed out that in any case a loss of leaf-size is probably a surer indication of loss of vigour than is a loss of total leaf-surface, for a tree with a few large healthy leaves is, no doubt, in a better condition than one with a number of small half-developed leaves, even though the total leaf-area in the latter case may be the greater. Indeed, when we bear in mind that the cut-back trees have been deprived of about two-thirds of their leaf-bearing branches, it is somewhat surprising that the total leaf-area is not in every case smaller than in those trees which have not been cut back.

As to the relative merits of cutting back at once on planting, or only after the first year, when the total cutting back in the two cases is the same in amount, our experiments do not at present lead to any certain conclusions. But it must be pointed out that delaying the cutting back

results in the loss of a crop of fruit in the second year (the loss was 82 per cent. in the weight, and 87 per cent. in the value), and involves the risk of some of the buds becoming "blind" and never starting at all; besides which, the mere fact that, during the first year, trees thus treated show a loss of 20 to 30 per cent. of leaf-size, and also of total leaf-area, as well as 70 to 80 per cent loss in growth, is strong evidence that they must have lost ground in some way, although the measurements in the following year may not show it. The question cannot, however, be definitely settled till the behaviour of the trees in subsequent years shall have been ascertained.

Pruning.

The various methods of pruning investigated in plots 5 to 9 were not (with the exception of plot 9, to which reference has already been made) subjected to leaf-measurement, and, as regards the growth and number of shoots, they all show values somewhat below the normal. In 5 and 6 where the trees had been pruned in the autumn, but none of the growth had been removed in the summer, the total growth measured in August, instead of being greater than that of the normal trees, as might have been expected (owing to none of it having been removed during the previous months), was actually less, showing that growth is discouraged by omitting summer shortening. In 7 and 8, where there was no autumn pruning, but only shortening of the growth in summer, there is a more marked decrease. We cannot, however, take this decrease as proving the disadvantage of omitting autumn pruning, for these plots are not strictly comparable with the others, the measurement of them being made shortly after, instead of shortly before, the application of the knife. The same remarks apply to the results in plot 9—summer pruning proper, but here we

have the evidence of the leaf-measurements to show that the treatment adopted has had a bad effect.

It must be mentioned that in all the experiments on pruning it was difficult to make the requisite distinctions in the extents to which the pruning was carried, owing to the scantiness of the growth during 1895 and the early part of 1896.

In plot 5, where we have no summer shortening and only moderate autumn pruning, the crop of fruit showed as much as 52 per cent. excess over the normal, the excess being shown by all three varieties; but, as in plot 6—which differs only from 5 in the autumn pruning being more severe—the excess was negligible, we cannot at present attach any weight to this result.

The following figures, which compare the results obtained by different methods of pruning in the case of dwarfs and standards, show that the effect on the dwarfs has been more marked, and that the effect on the standards has been, though generally in the same direction as that on the dwarfs, very small. As, however, the measurement of the growth (as also of the leaf-size) cannot be made in any strictly comparable manner where the trees are pruned differently, it is to the crop-measurements in subsequent years which we must look for a criterion of results in the case of all these experiments.

Treatment.	Wood-growth.		Number of Shoots.	
	Dwarfs.	Standards.	Dwarfs.	Standards.
No summer shortening - -	−12	− 2	−17	− 2
No autumn pruning - -	−20	+12	− 7	− 7
Summer pruning proper -	−64	− 5	−32	−16

Root-pruning and Lifting.

Comparing the growth-measurement in plots 14 and 56, we find that root-pruning and replanting have caused nearly the same loss—92 and 91 per cent. respectively. In both cases actual replanting occurred, but in the root-pruning experiments the trees were replanted at once after being lifted, whereas in the other experiment they were left in a shed for two days before replanting. The extra damage done by this treatment, however, is shown by the leaf-measurements, the loss of leaf-size being 53 per cent., as against 39 per cent. in the case of the root-pruned trees. In 15, where the lifting and replanting were accompanied by as little damage to the roots as possible, the wood-growth is seen to be comparatively little affected (a loss of 22 per cent.), and, judging by analogy with other cases, the leaf-size, if determined, would have been found to show hardly any effect at all. The crop of fruit from the "lifted" trees was within 1 per cent. of the average, and the average size of the fruit had not been appreciably affected, that from the root-pruned trees showed a deficiency of 61 per cent. as to weight, and 66 per cent. as to "value," while in the case of the "replanted" trees, the deficiency was about 80 per cent.

Effect of Manures.

We had hardly expected that any measurable effect would have been produced by the different manures used, since there has at present been but one effective application of them: yet, looking at the results with plots 32 and 33, this does not appear to be the case, since the absence of any dressing has resulted in 23 per cent. loss of leaf-size, and the use of only half the ordinary

amount has produced a loss of exactly half this amount, namely, 11 per cent., the values in the case of the different varieties being very concordant throughout. In view of these very definite and consistent results, the values obtained in our other manurial plots afford matter for considerable surprise.

Our artificial manure contains the three elements held to be of most importance for nutrition—phosphorus, potassium and nitrogen—as well as two others of less importance—magnesium and calcium—the latter being present in the superphosphate. Now, our three experiments (22, 23 and 24), in which each one of the three important elements is in turn omitted, all yield normal results. The omission of phosphorus may perhaps be taken, in view of the fact that the values with all the varieties of apples are very concordant, to cause a little loss (6 per cent.), but that will not account for the 23 per cent. loss when no manure is applied, and the omission of either potassium or nitrogen, though giving less concordant results with the different varieties, gives mean values within 1 per cent. of the normal.* The apparent conclusion to be drawn from these results is that neither of these three elements have any effect on the leaf-size of the tree, and that this must be effected solely by one or both of the other two elements in our manure—magnesium or calcium (and we might add sulphur, which is present as sulphate); but such a conclusion seems at present so improbable, that it would obviously be unwarrantable to draw it without any direct experiments in which these last-named

* The normal plot nearest to these plots is No. 21: plot No. 33, where a half-dose of manure was applied, has also a normal plot next to it; so that any explanation of the results based on the idea of a variation of the soil would be highly improbable.

elements were omitted. Such experiments we did not think would be necessary, and they will have to be added as supplementary ones.

In further evidence as to the absence of effect produced on the leaf-size by enriching the soil, we may refer to plots 27 and 28, where, in addition to the ordinary dressing, the ground, in the one case, received 30 tons to the acre of stable manure before planting, and, in the other, 12 tons annually, without any effect being produced on the leaf-size by these extra dressings*; again, in plot 53, where peat was mixed with the soil, and where, on analysis, the mixture was found to contain about 50 per cent. more nitrogen than the neighbouring soil, the leaf-size is also practically normal. We may also take the general results with the normal trees as compared with the composition of the soil: the soil in the lower part of the ground is, according to the analysis, nearly twice as rich in the three important food constituents as that in the upper portion, and the alteration in the appearance of the soil is so clear that the point at which it begins is evident on mere inspection: it is at 55 in Bramley, 53 in Cox, and 52 in Potts: yet when we look at the measurements of the normal plots in Fig. 5 (p. 63), we see that this change has produced no alteration in the leaf-size, the values all varying uniformly from plots 10 to 60.

The results mentioned in the preceding paragraph, though having an important bearing on our results with the other manurial experiments, do not, it must be pointed out, present the same difficulties as those do, or, at any rate,

* Unfortunately no measurements were made of plot 27 in 1895, so that we cannot say whether the manure applied in the trenching had a transitory effect in the year after its application or not, though it is probable that there was no such effect, as there was none in the case of No. 28, where annual dressings of dung were applied.

would not if they stood alone: for the excess of food constituents in these cases may be more apparent than real, since an analysis merely tells us what is present, and not whether it is present in a form assimilable by the plant, or, again, if present in an assimilable form, it may have affected features of the trees other than the leaf-size. But the difficulty in the manurial experiments is that in them the three food constituents taken separately have no effect, whereas when taken together, and exactly in the same form, they have a marked effect.

That an excess of food constituents in certain forms will produce greater leaf-size than in our normal plots is shown by the results where the trees were planted in rich compost (No. 55), there being here an average increase of 16 per cent., though the increase is confined to two out of the four varieties investigated. That differences in soil may produce other evidences of vigour without affecting the size of the leaf may be seen from the results of the peat plot (No. 53), where the leaf-size is practically unaltered, although the growth has been increased by 68 per cent.;* and the general results with the normal plots, as has been mentioned (p. 70), where the growth, but not the leaf-size, varies with the richness of the soil, affords another illustration in point.

In the manurial experiments themselves (plots 22 to 38) the results of the growth measurements agree thoroughly with those of the leaf-size, in showing no alteration to be produced by altering the character or conditions of the dressing, and they show the same in other cases where the leaf-size was not determined. Only

* In both the peat and compost plots three-feet holes were dug out and then filled with the mixture. It is impossible in these experiments to separate the effect of the composition of the mixture from that of the mechanical texture of the soil, and of the ground being dug deeper than, in the normal trenching.

in those cases where no manure, or a half-dose of it, was applied (Nos. 32 and 33) is there any discrepancy, for though the growth, equally with the leaf-size, shows a diminution, it is on the whole less than that of the leaf-size, instead of greater, as would be expected from analogy with other cases.

The experiment with Standards, 193, in which nitrate is omitted, also shows the absence of any effect therefrom on the growth of wood.

Attention may be directed to one apparently anomalous result as regards growth, namely, the increase (47 per cent.) uniformly produced with all the dwarf apples by applying the nitrate in July. This might be explained by the application of the nitrate in this case having been succeeded by a fair amount of rain in August and a considerable amount in September, being thereby rendered available for late wood-growth; but in view of the fact that a similar increase is shown by the neighbouring plot 41, where the nitrate was applied in the preceding autumn, and also that the plot of standards which were dressed with nitrate in July showed no increase, it is safer to attribute this result to some accidental circumstance.

As to leaf-size, the only instance which seems to point to any of the main constituents of our artificial manures producing a definite effect is in plot 40, where the nitrate was applied in July instead of in spring. In such a case we should imagine that its effect on the tree would be less, especially in a dry season, and in apparent accordance with this, we find that the leaf-size in the majority of cases is below the normal (8 per cent. on the average): but in view of the fact that the absence of nitrate altogether has produced no reduction, we must set the reduction in this case down as accidental.

The whole question of manures is evidently one which presents many points of interest and of difficulty, and several years must elapse before sufficient data from which to draw any certain conclusions respecting it can be collected. We are inclined to attribute the general absence of effect produced so far solely to the dryness of the last two seasons, which prevented the artificial manures from ever reaching the roots so as to be available as food constituents: they would, however, be dissolved to a certain extent by dews and occasional showers, and the solutions formed would evaporate immediately afterwards, leaving a slight incrustation on the surface, which would fill the pores of the soil, and thereby keep the lower layers moist. In this mechanical way the manure might, as Professor Warrington has pointed out to us, benefit the trees, as we find it has done in experiments 32 and 33; but the results would be more or less independent of the nature of the manure, and of the omission of one or other of its constituents, just as we find was the case in our other experiments.

Although this may be the explanation of our results with artificial manure, it does not explain why in the two cases where stable manure was applied no effects were produced, either when it was dug in before planting, as in 27, or when it was applied as a mulching, as in 28. It might certainly have been anticipated that, even if only in a mechanical manner, the dressing would have affected the soil, and consequently the trees. In connection with this it may also be noticed that a mulching of clean straw, as in plot 16, instead of producing a good effect—as might have been expected owing to its preventing evaporation—has resulted in every case in a diminution of vigour in the trees, as measured both

by the growth and by the number of shoots—34 per cent. in the former, and 16 per cent. in the latter.

Planting in different Seasons.

In plots 56, 57, and 58 the trees were planted in autumn, winter, and spring respectively, the dates being November 28th, 1895, January 7th, 1896, and March 3rd, 1896. In view of the prevalent idea that planting in autumn is much preferable to planting in any other season, we have been surprised to find that our experiments indicate a diametrically opposite conclusion. The winter-planted trees show a mean gain of 4 per cent. in leaf-size over the autumn-planted ones, and those planted in spring show a still larger gain of 7 per cent. Although all the values with the three varieties are very concordant, the total increase is small, but it is emphasised by the values for the total leaf-area, which were also determined, and which give in both cases an increase of 41 per cent. for the winter- and spring-planted trees over the autumn-planted ones, the increase being uniformly shown by each of the three varieties. The values are as follows:—

PERCENTAGE INCREASE IN TOTAL LEAF-AREA PRODUCED BY WINTER- AND SPRING-PLANTING AS COMPARED WITH AUTUMN-PLANTING.

Plot.	Bramley.	Cox.	Potts.	Mean.
57, planted in winter -	+ 37	+ 36	+ 49	+ 41
58, „ spring -	+ 33	+ 18	+ 72	+ 41

In the same way the wood-growth (Table 3) shows the autumn-planted trees to compare unfavourably with those planted in winter or in spring, to the extent of 58 and 13 per cent. respectively, and the number of shoots does the same, to the extent of 28 per cent. in both cases (Table 4).

It is quite possible that this result may be due to the autumn-planted trees having been subjected accidentally to some more unpropitious circumstance during the planting than were the other trees, and we think that it will be well to repeat and extend our experiments before drawing any definite conclusions, and especially to include planting at more than one date in the autumn and spring seasons.

We may, however, mention, as having an interesting bearing on this question, that Mr. Walter Lawrence informs us that in Kashmir planting is always done in the spring, and that one of the few points on which he failed to induce the natives to acknowledge the superiority of European methods of horticulture was in the substitution of autumn- for spring-planting.

Different Soils.

The increase in vigour as measured by the wood-growth, caused by planting in peaty or very rich soil, as in plots 53 and 55, has already been noticed; mixing chalk, stones or gravel with the soil produces, on the other hand, a diminution of growth, which is practically negligible in the first case, and considerable (38 per cent.) in the last. This effect is, doubtless, due to the substances thus added to the soil having increased the means of evaporation, and consequently produced a bad effect in the past dry season.

To the reverse cause is probably due the increase observed in plot 47, where the trees were planted in holes at the bottom of which was rammed a layer of chalk, there being in this case an increase of 17 per cent. in the growth. The standard trees, which were similarly treated (Nos. 199, &c.), show a still greater increase—29 per cent.

High and Low Planting, &c.

In plots 48 and 49 the trees were planted about 10 c.m. (4 inches) higher and lower, respectively, in the ground than were the normal trees. The result in both cases is a mean loss of 7 per cent. of leaf-size, the loss being shown chiefly by Cox, and not at all by Bramley. The smallness of the loss in the case of the low-planted trees, and the fact that when we look at the values for the wood-growth we find an increase, is rather surprising, considering how generally (and, no doubt, rightly) low planting is condemned: but the excessive drought of 1895 and 1896 would, doubtless, tend to reduce the ill-effects of such a practice, while, on the other hand, it would tend to make high planting more trying to the trees, so that the present results in these two cases cannot be regarded as applicable to an average season. The standards which were planted too low show a loss of 10 per cent. of growth, instead of the increase of 37 per cent. shown by the dwarfs.

In plot 46 the trees were planted in circular holes 1 m. (3 ft.) deep, and 1 m. in diameter, in which the layers of earth had been replaced in the same order in which they had been removed. The extra breaking up of the soil, and the way in which these holes would act as wells, seem to have produced a beneficial action in

the dry seasons after planting, for there is a gain of 8 per cent. in leaf-size. It is possible that here, also, the results might have been different in a less exceptional season.

In plot 20 the ground was dug three times during the year as close to the roots as was possible without visibly injuring them, imitating, so far as the digging was concerned, the treatment which trees would receive if vegetables were grown near them, as in most kitchen gardens. There is a loss of leaf-size in every case, amounting to 8 per cent. on the average, which tends to show that such treatment has a bad effect; but, as no similar effect is noticeable in the growth measurements, it cannot be insisted on at present.

The only other plot to be mentioned is No. 60, which contains trees which had received some damage, chiefly by hares, before planting. Judging by their appearance they seemed to have recovered from their injuries, but the leaf-measurements show that this was not entirely the case, there being still a deficit of 5 per cent. in size.

Although many of our results must, as we have already pointed out, be accepted at present as preliminary only, and although none of the properties examined—leaf-size, total leaf-surface, wood-growth, &c.—can be accepted as affording a direct measure (in the mathematical sense) of the vigour of a tree, we think that the results cannot fail to be eminently satisfactory from one important point of view, besides that of the concordance of the various methods of examination previously discussed. We have seen how, in nearly every case, differences of treatment, sometimes apparently trival, produce effects, both on leaves and wood, which are easily recognisable

by simple measurements, although in nine cases out of ten a mere inspection of the trees would reveal no differences at all; and we may safely conclude that in such measurements we possess a very delicate gauge of the condition of a tree, and that horticultural problems may be easily attacked by rigorous scientific methods.

Results with Strawberries.

The widespread interest evinced in strawberries must be our excuse for making mention of our results with them in this Report, for these results depend at present on measurements of the crops of one season only. The majority of the plants, it is true, were planted in 1894, but they were planted at such different periods that they could not be considered to be in a comparable condition in the following season, and, moreover, as the crop in 1895 suffered much from an insect pest, it was too small for any purpose of useful comparison: even as regards those varieties (34 in number) which were planted in good time in 1894 (August 3rd to 20th), the crop was 80 per cent. smaller than that from similar one-year plants in 1896, and the individual berries were 24 per cent. smaller.

The strawberries planted in 1894 constitute the two-year plants, of which the crops are recorded in Tables 8 and 9, the values obtained from one-year plants in the same season (1896) being also entered in the same tables. These plants are all on the raised border at the upper boundary of the ground, and the values are deduced from 13 plants of each variety and of each age, except where losses have occurred since planting.

In Table 8 the weights of the crops in grams per plant are given in columns II. and IV., the varieties being arranged in the order of magnitude of the crop from the one-year plants. [The names of the varieties have been abbreviated in some cases to economise space; they will be found in full in the list on p. 23.] The crops obtained from the two-year plants are, of course, larger than those from the younger plants, and, as it

TABLE 8.—WEIGHT (in grams per plant) OF CROPS OF STRAWBERRIES FROM THE BORDER.
(Nos. 380 to 459 and 589 to 594).

Variety.	One-year Plants.		Two-year Plants.		Mean. Relative.	Percentage Difference. Actual Values.	Flavour.	Character.	Dates‡ of Gathering from Two-year Plants.		Duration of Cropping. Days.
	Actual.	Relative.*	Actual.	Relative.†					First.	Last.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Marguerite - -	213	188	227	134	161	7	2	3	12	**1**	20
King of the Earlies - -	206	172	168	99	136	− 18	2	1	5	29	25
Enchantress - -	192	169	237	139	154	23	2	1	19	**8**	20
J. Veitch - - -	187	165	251	148	157	34	3	1	12	**8**	27
Teutonia - - -	184	162	229	135	149	25	2	2	7	**4**	28
Sir Harry - - -	166	146	225	132	139	36	3	3	12	**8**	27
Jubilee - - -	165	145	189	111	128	14	3	3	13	**20**	38
Sir J. Paxton - -	162	143	223	131	137	140	1	1	16	**8**	23
Admiral Dundas - -	156	137	101	59	98	− 35	2	1	22	**13**	21
President - - -	145	128	147	87	108	2	2	1	17	**8**	22
British Queen - -	142	125	184	108	117	29	0·5	1	24	**13**	20

* = actual ÷ 1·135. † = actual ÷ 1·700. ‡ The thick type indicates dates in July, the others are dates in June.

TABLE 8.—WEIGHT (in grams per plant) OF CROPS OF STRAWBERRIES FROM THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean. Relative.	Per-centage Difference. Actual Values.	Flavour.	Character.	Dates‡ of Gathering from Two-year Plants.		Duration of Cropping. Days.
	Actual.	Relative.*	Actual.	Relative.†					First.	Last.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Austria	141	124	138	81	103	2	3	3	17	**4**	18
Cockscomb	141	124	207	122	123	47	2	2	19	**13**	25
White Knight	138	122	203	119	121	47	3	3	13	**4**	22
Lord Suffield	133	118	191	113	116	44	2	1	24	**13**	20
Bothwell Bank	129	114	221	130	122	71	2	1	13	**8**	26
Frogmore Late Pine	129	114	89	53	84	− 31	2	2	24	**15**	22
Sensation	125	110	228	134	122	83	3	3	12	**8**	27
Geo. Rundle	119	105	151	89	97	26	2	1	24	**13**	20
McMahon	117	103	201	118	111	71	2	1	17	**13**	27
Commander	115	101	91	54	78	− 23	3	3	17	**8**	22
The Albert	115	101	125	74	88	9	3	4	19	**13**	25

* = actual ÷ 1·135. † = actual ÷ 1·700. ‡ The thick type indicates dates in July, the others are dates in June.

TABLE 8.—WEIGHT (in grams per plant) OF CROPS OF STRAWBERRIES FROM THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean. Relative.	Per-centage Difference. Actual Values.	Flavour.	Character.	Dates‡ of Gathering from Two-year Plants.		Duration of Cropping. Days.
	Actual.	Relative.*	Actual.	Relative.†					First.	Last.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Scarlet Queen	115	101	201	118	110	75	2	2	8	**8**	30
Black Prince	114	100	136	80	90	19	2·5	1	16	29	14
Competitor	110	97	165	97	97	50	3	2	16	**8**	23
Crescent Seedling	108	96	212	124	110	96	2	1	4	29	26
Pres. Delacour	105	92	196	115	104	86	3	3	17	**8**	22
Aberdeen Favourite	105	92	196	115	104	61	2	1	22	**13**	21
Souvenir de Kieff	100	88	146	86	87	46	3	3	24	**20**	27
Bubach (American)	97	86	189	111	99	95	3	2	12	**8**	27
J. Ruskin	96	85	199	116	101	109	2	2	10	**8**	29
Dr. Hogg	90	79	167	98	89	85	1	1	22	**13**	21
Laxton's No. 1	90	79	206	121	100	143	2	1	3	26	24

* = actual ÷ 1·135. † = actual ÷ 1·700. ‡ The thick type indicates dates in July, the others are dates in June.

TABLE 8.—WEIGHT (in grams per plant) OF CROPS OF STRAWBERRIES FROM THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean. Relative.	Per-centage Difference. Actual Values.	Flavour.	Character.	Dates‡ of Gathering from Two-year Plants.		Duration of Cropping. Days.
	Actual.	Relative.*	Actual.	Relative.†					First.	Last.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Pauline - - -	89	78	75	44	61	− 16	4	2	9	29	21
Vic. Héricart de Thury -	89	78	128	75	77	44	1	1	10	**4**	25
Latest of All - - -	85	75	152	89	82	79	2	1	**1**	**20**	20
A. F. Barron - -	85	75	161	95	85	89	2	2	19	**8**	20
Aug. Nicaise - - -	84	74	196	115	95	135	1	1	16	**8**	23
Royal Sovereign - -	84	74	181	107	91	115	1	1	4	**8**	35
Dr. Morere - - -	81	71	96	56	64	23	2	1	17	**1**	19
Eleanor - - -	79	70	136	80	75	72	3	3	13	**20**	38
Lucas - - -	77	68	138	81	75	79	3	2	17	**8**	22
Gart. Dir. O. Hüttig -	77	68	170	100	84	123	3	2	17	**13**	27
Stirling Castle - -	76	67	188	111	89	149	2	1	17	**13**	27

* = actual ÷ 1·135. † = actual ÷ 1·700. ‡ The thick type indicates dates in July, the others are dates in J une

TABLE 8.—WEIGHT (in grams per plant) OF CROPS OF STRAWBERRIES FROM THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean. Relative.	Per-centage Difference. Actual Values.	Flavour.	Character.	Dates‡ of Gathering from Two-year Plants.		Duration of Cropping. Days.
	Actual.	Relative.*	Actual.	Relative.†					First.	Last.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Emp. Eugénie - -	71	62	183	108	85	158	2	2	19	**8**	20
Loxford Hall - -	71	62	61	36	49	— 14	2	1	29	**13**	15
Ed. Lefort - - -	65	57	200	118	88	207	1	1	8	29	22
Sharpless - - -	63	55	63	37	46	0	3	1	9	**1**	23
Sir C. Napier - -	62	55	136	80	68	120	2	1	19	**8**	20
Andrew Desportes - -	60	53	70	41	47	16	2	3	13	**13**	30
Empress of India - -	60	53	181	101	77	202	2	1	19	**13**	25
Kitley's Goliath - -	58	51	132	78	65	126	2	2	24	**13**	20
La Constante - -	57	50	185	109	80	49	1	1	15	**4**	20
D. of Edinburgh (No. 1) -	57	50	98	58	54	72	2	1	17	**4**	18
Noble - - -	56	49	51	30	40	— 9	2	3	9	19	11

* = actual ÷ 1·135. † = actual ÷ 1·700. ‡ The thick type indicates dates in July, the others are dates in June.

TABLE 8.—WEIGHT (in grams per plant) OF CROPS OF STRAWBERRIES FROM THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean. Relative.	Per-centage Difference. Actual Values.	Flavour.	Character.	Dates‡ of Gathering from Two-year Plants.		Duration of Cropping. Days.
	Actual.	Relative.*	Actual.	Relative.†					First.	Last.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Gunton Park	55	48	128	75	62	131	2	1	22	**13**	21
Red Alpine	55	48	91	54	51	66	3	1	13	31§	80
Alice Maud	52	46	52	31	39	3	2	2	12	**1**	20
Amateur	51	45	150	88	67	193	2	2	19	**8**	20
Pioneer	50	44	215	126	85	(329)	2	1	15	**4**	20
Souvenir de Bossuet	49	43	136	80	62	177	2	3	13	**8**	26
Keens' Seedling	48	42	114	67	56	137	2·5	1	8	**4**	27
Preston Seedling	46	41	116	68	55	151	2	1	13	**4**	22
Waterloo	45	40	107	63	52	138	2	3	26	**15**	20
La Grosse Sucrée	42	37	153	90	64	(266)	1	1	10	29	20
Myatt's Prolific	38	33	43	24	29	16	3	2	15	**13**	29

* = actual ÷ 1·135. † = actual ÷ 1·700. ‡ The thick type indicates dates in July, the others are dates in June. § 31st of August.

TABLE 8.—WEIGHT (in grams per plant) OF CROPS OF STRAWBERRIES FROM THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean. Relative.	Per-centage Difference. Actual Values.	Flavour.	Character.	Dates‡ of Gathering from Two-year Plants.		Duration of Cropping. Days.
	Actual.	Relative.*	Actual.	Relative.†					First.	Last.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Mrs. Laxton - -	37	33	89	52	43	140	3	3	22	**8**	17
Countess - - -	35	31	48	28	30	37	3	2	19	**4**	16
Premier - - -	34	30	61	36	33	79	3	2	15	**4**	20
Filbert Pine - - -	33	29	99	58	44	201	2	1	13	**8**	26
D. of Edinburgh (No. 2) -	32	28	127	75	52	30	2	1	17	**8**	22
Helena Gloede - -	26	23	55	32	28	111	2	2	13	**1**	19
La France - - -	24	21	74	44	33	208	2	2	19	**8**	20
Captain - - -	22	19	41	24	22	85	2	1	12	**1**	20
Bicton Pine - -	22	19	..	..	..	..	2	3	..	..	..
Lord Napier - - -	21	18	42	25	22	102	2	1	17	29	13
Old Pine - - -	17	15	66	39	27	(288)	1	1	24	**13**	20

* = actual ÷ 1·135. † = actual ÷ 1·700. ‡ The thick type indicates dates in July, the others are dates in June.

TABLE 8.—WEIGHT (in grams per plant) OF CROPS OF STRAWBERRIES FROM THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean. Relative.	Per-centage Difference. Actual Values.	Flavour.	Character.	Dates‡ of Gathering from Two-year Plants.		Duration of Cropping. Days.
	Actual.	Relative.*	Actual.	Relative.†					First.	Last.	
I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
Boothby's Sweetheart -	13	11	147	86	48	(871)	3	2	17	**13**	27
Unser Fritz - -	13	11	37	21	16	(185)	2	2	29	**13**	15
Elton Late Pine - -	13	11	97	57	34	(646)	1	1	22	**4**	13
Geo. Lesuir - -	12	11	61	36	24	(408)	3	2	22	**6**	15
Comte de Paris - -	2	2	..	..	..	..	3	2	..	..	..
Mean - -	84	74	141	83	79	109‖	..	..	..	..	..
§Monarch - - -	82	72	..	..	..	..	1	1	..	..	..
§Leader - - -	53	47	..	..	..	..	1	1	..	..	..
§Stevens' Wonder - -	3	3	..	..	..	..	2	2	..	..	..
§Hautbois - - -	0	0	..	..	..	..	..	..	..	..	..

* = actual ÷ 1·135. † = actual ÷ 1·700. ‡ The thick type indicates dates in July, the others are dates in June.

§ The one-year plants of these varieties were obtained from runners which were bought, and not raised on the ground: they may, therefore, not be strictly comparable with the others.

‖ Omitting those in brackets this mean becomes 79. The percentage increase deduced from the means of the actual crops of the two ages (84 and 41) is 68.

is difficult to see on mere inspection of columns II. and IV. whether any particular variety has done better at one age than at another, we have given in columns III. and V. the *relative* values of the crops as compared with the mean from certain selected varieties of the corresponding ages, the mean crop from these varieties being called 100 in each case. The varieties selected were: Crescent Seedling, Sensation, Noble, Sir C. Napier, J. Veitch, Sir J. Paxton, President, British Queen, Kitley's Goliath and Dr. Hogg. To give an instance by way of explanation: the one- and two-year plants of Austria gave relative crops of 124 and 81 respectively; this means that the one-year plants yielded 24 per cent. more than the *one-year* plants of the above varieties did on the average, and that the two-year plants yielded 19 per cent. less than did *two-year* plants of these same varieties.

In column VI. we have given the means of the relative crops of the two ages. These values, of course, indicate the relative magnitude of the crops obtained from different varieties during two years.

In column VII. we give the percentage excess (or deficit) of the actual crop from two-year plants over that from one-year plants. The number of cases in which there is a deficit, it will be seen, is very small: the mean of all the numbers in this column indicates that the former is, on the average, more than double (109 per cent. increase) that of the latter, or, omitting certain evidently exceptional cases, 79 per cent. larger; but taking the mean in this way is somewhat fallacious, owing to the occurrence of a few excessive values, which apply to cases where the crops have been exceptionally, and perhaps accidentally, small. A safer way of comparing the crops is to take the means of all the values for each

age separately, and then compare these means with each other: these are 84 and 141, and show, therefore, an excess of 68 per cent. for the crop of two-year plants over that of one-year plants.

On looking down the values in column VII., it will be seen that the increase in crop with age is very different in the case of different varieties, and the same conclusion may be drawn by noticing that the order of magnitude of the crops from two-year plants (columns IV. and V.) is by no means identical with that from one-year plants (columns II. and III.): yet, if we take the means of several varieties together, instead of the results with each individual one, it is evident that the same general order of magnitude is maintained at the two ages. Thus, dividing the above list of varieties (arranged as it is in the order of magnitude of the crop from one-year plants) into four lots of 20 each, we get (taking actual values)—

Mean Crop from	1st 20.	2nd 20.	3rd 20.	4th 20.
One-year plants - - -	154	98	63	28
Two-year plants - - -	191	161	131	81
Percentage increase - -	32	68	104	214

Figures which show that the cropping powers of these batches of 20 varieties follow the same order, whether the plants are one year or two years old.

The last line of "percentage increase" shows that the varieties which yield smaller crops as one-year plants show a larger percentage increase as the plants get older, and, *vice versâ*, the less fertile varieties tending to overtake their more precocious fellows: but whether this is really a result of precocity, and a consequent absence

of lasting power, or whether it is merely due to the crops from certain varieties being accidentally small or large in one or other case, we have not at present sufficient evidence to prove, although one point will be mentioned immediately, which indicates that it is not merely accidental.

The average weights of the berries from the different varieties are given in Table 9, and are treated in the same way as the total weights of fruit. The general results of the comparison of the fruit from plants of the two ages is to show a considerable reduction in size as the plant gets older. The mean reduction in the case of these 80 varieties is over 22 per cent., and there are only very few cases where the two-year plants yield larger fruits than the one-year ones. The decrease in size varies considerably with different varieties, and the order in which the varieties stand as regards size of fruit depends on the age of the plant: but, as in the case of cropping powers, the same general order prevails, as may be seen from the following values, which give the means deduced from successive batches of 20 varieties taken in the order given in table:—

Mean Weight of Berry from	1st 20.	2nd 20.	3rd 20.	4th 20.
One-year plants * - - -	9·38	6·32	5·06	3·61
Two-year plants - - -	5·96	4·39	4·22	3·32
Percentage decrease - -	−36	−29	−19	− 6

* Those varieties of which there were no representatives as two-year plants have been omitted in these means.

Here, also, we find a fact similar to that observed in the case of the total crop, namely, that the larger the berry of the one-year plants, the more does it deteriorate in size as the plants get older, not simply in actual

size but in relative size, expressed as a percentage of its former magnitude. But here there is evidence that the change is due to a real deterioration in the plant, and not to any accidental circumstance, such as a comparative heaviness of total crop consequent on favourable circumstance during the flowering period, for in the cases where the deterioration of the size of the fruit has been least, the increase in crop has been above the average. Thus, the 20 varieties which show the smallest deterioration in size yielded a crop 127 per cent. greater than their one-year brothers, whereas the mean increase in crop for the whole 80 varieties is only 109 per cent.* Similarly, if we take from Table 8 the 20 varieties which show the greatest increase in crop, we find that individual berries of these varieties are also abnormally large: they show a deficit of only 17·3 per cent., as compared with those from one-year plants, whereas the average deficit of the 80 varieties is 22·3 per cent.

TABLE 9.—AVERAGE WEIGHTS (in grams) OF SINGLE STRAWBERRIES FROM PLANTS IN THE BORDER. (Nos. 380 to 459 and 589 to 594.)

Variety.	One-year Plants.		Two-year Plants.		Mean Weights.	Percentage Difference in Actual.
	Actual.	Relative.†	Actual.	Relative.‡	Relative.	
Geo. Lesuir	13·6	190	6·0	111	151	− 56
Helena Gloede	11·7	164	7·2	133	149	− 39
Stevens' Wonder	11·3	158	..	..	..	..
Sensation	10·5	147	6·7	124	136	− 38

* Or, if the exceptional values enclosed in brackets in Table 8 are omitted in both cases, the increase is 83·5, as against a mean of 79 per cent.

† Actual ÷ 7·14.

‡ Actual ÷ 5·42. Small apparent discrepancies may be observed between the actual and percentage values, due to the former being quoted only to the nearest figure in the first decimal place.

TABLE 9.—AVERAGE WEIGHTS (in grams) OF SINGLE STRAWBERRIES FROM PLANTS IN THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean Weights.	Percentage Difference in Actual.
	Actual.	Relative.*	Actual.	Relative.†	Relative.	
Monarch	10·4	146	..	..	..	..
Laxton's Noble	10·4	146	9·9	183	165	— 4
J. Veitch	10·2	143	7·2	133	148	— 29
McMahon	10·0	140	5·4	118	129	— 34
Captain	9·7	136	6·4	118	127	— 34
Marguerite	9·5	133	6·8	125	129	— 29
Admiral Dundas	9·3	130	6·2	115	123	— 34
Waterloo	9·3	130	8·6	159	145	— 7
Leader	9·2	129	..	..	..	..
White Knight	8·9	125	6·6	122	124	— 26
Sharpless	8·9	125	1·0	33	79	— 88
La France	8·8	123	6·7	124	124	— 24
Empress of India	8·6	120	5·1	94	107	— 41
Competitor	8·4	118	4·3	81	100	— 49
Teutonia	8·3	116	5·7	105	111	— 31
Latest of All	8·0	112	4·1	76	99	— 49
Royal Sovereign	8·0	112	5·8	107	110	— 27
Empress Eugénie	7·8	109	5·3	98	104	— 33
D. of Edinburgh (No. 2)	7·6	106	4·4	81	94	— 42
Frogmore Late Pine	7·5	105	4·6	85	95	— 38
Alice Maud	7·4	104	3·5	65	85	— 53

* Actual ÷ 7·14.

† Actual ÷ 5·42. Small apparent discrepancies may be observed between the actual and percentage values, due to the former being quoted only to the nearest figure in the first decimal place.

TABLE 9.—AVERAGE WEIGHTS (in grams) OF SINGLE STRAWBERRIES FROM PLANTS IN THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean Weights.	Percentage Difference in Actual.
	Actual.	Relative.*	Actual.	Relative.†	Relative.	
Unser Fritz	7·4	104	2·8	52	78	— 62
Premier	7·4	104	4·2	77	91	— 43
Aug. Nicaise	7·3	102	5·9	109	106	— 20
Loxford Hall	7·2	101	5·0	92	97	— 31
Bothwell Bank	7·0	98	5·5	102	100	— 22
La Constante	7·0	98	5·3	98	98	— 25
G. Rundle	6·6	92	5·6	103	98	— 15
Enchantress	6·6	92	4·6	85	89	— 30
Austria	6·5	91	4·4	81	86	— 33
Sir C. Napier	6·4	90	4·2	78	84	— 34
Kitley's Goliath	6·3	88	4·7	87	88	— 25
Comte de Paris	6·3	88	..	..	..	..
Sir J. Paxton	6·2	87	4·7	87	87	— 25
Cockscomb	6·2	87	5·6	103	95	— 10
La Grosse Sucrée	6·0	84	5·2	96	90	— 14
Filbert Pine	5·9	83	3·5	65	74	— 41
President	5·8	81	3·9	72	77	— 32
British Queen	5·7	80	4·5	83	82	— 21
Dr. Morere	5·7	80	3·4	63	72	— 41
Souvenir de Bossuet	5·7	80	8·1	150	115	+ 42
Scarlet Queen	5·7	80	5·2	96	88	— 8

* Actual ÷ 7·14.

† Actual ÷ 5·42. Small apparent discrepancies may be observed between the actual and percentage values, due to the former being quoted only to the nearest figure in the first decimal place.

TABLE 9.—AVERAGE WEIGHTS (in grams) OF SINGLE STRAWBERRIES FROM PLANTS IN THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean Weights.	Percentage Difference in Actual.
	Actual.	Relative.*	Actual.	Relative.†	Relative.	
Commander - -	5·6	78	3·9	72	75	— 49
Dr. Hogg - -	5·6	78	4·0	74	76	— 29
Gart. Dir. O. Hüttig -	5·5	77	4·4	81	79	— 19
Countess - -	5·4	76	4·6	85	81	— 15
Bubach (American) -	5·3	74	5·0	92	83	— 7
Souvenir de Kieff -	4·9	69	3·7	68	69	— 25
Eleanor - -	4·9	69	3·8	70	70	— 22
Pioneer - - -	4·9	69	4·4	81	75	— 10
D. of Edinburgh (No. 1)	4·8	67	4·5	83	75	— 7
Boothby's Sweetheart -	4·8	67	3·1	57	62	— 37
Old Pine - -	4·8	67	3·3	61	64	— 45
Edouard Lefort -	4·7	66	4·4	81	74	— 7
Lord Suffield - -	4·7	66	3·1	57	62	— 34
Jubilee - -	4·7	66	4·3	79	73	— 7
Mrs. Laxton - -	4·5	63	4·0	74	68	— 10
Aberdeen Favourite -	4·5	63	3·5	65	64	— 21
Andrew Desportes -	4·5	63	3·7	68	66	— 18
Crescent Seedling -	4·4	62	4·2	77	70	— 4
Vic. Héricart de Thury	4·4	62	4·0	74	68	— 9
J. Ruskin - -	4·4	62	3·8	70	66	— 14
Sir Harry - -	4·3	60	2·7	50	55	— 38

* Actual ÷ 7·14.

† Actual ÷ 5·42. Small apparent discrepancies may be observed between the actual and percentage values, due to the former being quoted only to the nearest figure in the first decimal place.

TABLE 9.—AVERAGE WEIGHTS (in grams) OF SINGLE STRAWBERRIES FROM PLANTS IN THE BORDER. (Nos. 380 to 459 and 589 to 594)—*continued.*

Variety.	One-year Plants.		Two-year Plants.		Mean Weights.	Percentage Difference in Actual.
	Actual.	Relative.*	Actual.	Relative.†	Relative.	
A. F. Barron	4·3	60	4·4	81	71	+ 3
Keens' Seedling	4·2	59	3·9	72	66	— 8
Laxton's No. 1	4·1	57	4·0	74	66	— 3
Stirling Castle	4·1	57	3·6	66	62	— 13
President Delacour	4·0	56	3·2	59	58	— 19
Bicton Pine	3·8	53	..	..	..	..
The Albert	3·8	53	2·7	50	52	— 27
Myatt's Prolific	3·6	50	3·0	55	53	— 14
Preston Seedling	3·5	49	2·8	52	51	— 20
Lord Napier	3·4	48	3·3	61	55	— 3
Gunton Park	3·4	48	3·0	54	51	— 11
Lucas	3·1	43	3·3	61	52	+ 8
Elton Pine	3·1	43	3·8	72	58	+ 21
King of Earlies	3·0	42	3·0	54	48	0
Black Prince	2·6	33	2·5	46	40	— 5
Pauline	2·2	31	2·6	48	40	+ 17
Amateur	2·2	31	2·5	46	39	+ 16
Red Alpine	0·6‡	9‡	0·6‡	11‡	10	— 5
Mean	6·22	87	4·45	82	85	—22·3§

* Actual ÷ 7·14.

† Actual ÷ 5·42. Small apparent discrepancies may be observed between the actual and percentage values, due to the former being quoted only to the nearest figure in the first decimal place.

‡ Not included in the means.

§ The average difference when calculated from the mean weights of the berries of the two ages (6·22 and 4·45) is — 28·5 per cent.

In column VIII. of Table 8 we have given our observations as to the flavour of the fruit. We have divided them, as far as possible, into three classes, numbered 1, 2 and 3, of which 1 represents the best flavour, and in cases where the flavour seemed to lie between two classes, we have called it 1·5 or 2·5, and, similarly, 0·5 signifies an especially fine flavour. In column IX. we give similar values representing the character (firmness or softness) of the fruit—a very important consideration for marketing purposes.

In columns X. and XI. we give the dates of the first and last gatherings from the two-year plants, the dates in June being given in ordinary type, and those in July in heavy type. The fruiting of the one-year plants was, with very few exceptions, earlier than that of the older ones, the first pickings being on the average 1·66 days earlier. The older plants, however, go on bearing longer, the last gatherings from the two-year plants being on the average 3·38 days later than those from the one-year plants. The duration of the fruiting season with the two-year plants is given in column XII.

How far our results as to the weight of fruit yielded by different varieties may hold good in other localities, or in other seasons, we are very doubtful. We have in other parts of the ground strawberries which have been treated in a systematic manner, and the differences between the results obtained from them, and from the plants on the border, are considerable. The difference between the mean results points to the fact that the strawberry is very sensitive to small differences of certain circumstances, and this being the case, we should naturally expect different varieties to behave differently under different conditions.

The border, where are the plants which have already been discussed, has double the depth of soil which the rest of the field has: all the other plants are planted in the ordinary trenched soil in the field. We have about 70 plants of each of 60 varieties in the strips of ground, which will eventually be used as paths. These were planted at the same time as the corresponding varieties in the border, the same distance has been allowed between the plants, and the same amount of manure has been given to them. They are, however, closer together in one sense than the plants in the border, since in each strip of ground there are four rows, whereas on the border only two rows are at present together, each row having on one side of it a considerable space of ground from which to draw nourishment.

A comparison between the results from these plants in the ground with those from the plants in the border is given in Table 10. The varieties are arranged in the order of magnitude of the crops from the "border" plants, and the numbers give the percentage difference in the crop of the "ground" plants, as compared with that of the same variety in the border. The "ground" plants, it will be seen, generally yield less than the "border" ones, the average difference (omitting the results with Captain, which are evidently exceptional) being $-21 \cdot 3$ per cent.; but the differences vary so irregularly throughout the list that it is evident the same order of cropping qualities does not hold in the two sets of plants, except in a very rough way. Thus, for instance, out of the 20 largest croppers on the border, only 10 appear amongst the 20 largest croppers on the ground, and out of the 20 smallest croppers on the border, 10, also, appear amongst the last 20 on the ground.

TABLE 10.—PERCENTAGE EXCESS (+) DEFICIT (−) OF THE WEIGHT OF THE CROP FROM TWO-YEAR STRAWBERRIES IN THE GROUND, AS COMPARED WITH THAT FROM TWO-YEAR PLANTS IN THE BORDER.

Variety.	Difference per cent.	Variety.	Difference per cent.
J. Veitch	− 78	Empress of India	− 45
Enchantress	− 52	Royal Sovereign	− 47
Pioneer	− 68	Aberdeen Favourite	− 56
Teutonia	− 50	King of the Earlies	− 27
Sensation	− 37	Dr. Hogg	− 35
Sir Harry	− 68	Competitor	− 11
Sir J. Paxton	− 30	A. F. Barron	− 18
Bothwell Bank	− 19	La Grosse Sucrée	− 48
Crescent Seedling	− 21	Amateur	− 41
Laxton's No. 1	− 27	President	− 16
White Knight	− 79	Latest of All	− 11
McMahon	− 27	Lucas	− 25
Scarlet Queen	− 45	Sir C. Napier	− 13
Ed. Lefort	− 69	Eleanor	− 60
J. Ruskin	− 26	Black Prince	− 5
Aug. Nicaise	− 38	Souvenir de Bossuet	− 46
Pres. Delacour	− 28	Kitley's Goliath	+ 23
Lord Suffield	− 45	Vic. Héricart de Thury	+ 46
Jubilee	− 34	Gunton Park	− 23
Stirling Castle	− 10	The Albert	− 50
La Constante	− 10	Preston Seedling	− 62
British Queen	− 35	Keens' Seedling	− 4

TABLE 10.—PERCENTAGE EXCESS (+) DEFICIT (−) OF THE WEIGHT OF THE CROP FROM TWO-YEAR STRAWBERRIES IN THE GROUND, AS COMPARED WITH THAT FROM TWO-YEAR PLANTS IN THE BORDER (*continued*).

Variety.	Difference per cent.	Variety.	Difference per cent.
Waterloo	+ 10	Old Pine	− 78
Admiral Dundas	+ 50	Sharpless	+ 60
Dr. Morere	+ 9	Loxford Hall	− 33
Commander	− 25	Alice Maud	+ 77
Mrs. Laxton	+ 70	Noble	+ 2
Frogmore Late Pine	+ 40	Lord Napier	+ 31
Elton Pine	− 22	Captain	+219
Pauline	− 43	Unser Fritz	+ 67
La France	+ 42		

We have examined the results critically, with a view of ascertaining whether the differences with individual varieties may be attributed to any special circumstance under which the plants of them are placed, either in the ground or in the border, but without success: the varieties which show exceptional differences are distributed promiscuously over the plots. On looking at Table 10, it will be found that with the first 30 varieties entered (the varieties being arranged according to their order of cropping on the border) the average deficit of the "ground" plants is 42·6 per cent., whereas with the second 30 it is only 1 per cent.; but all that can safely be concluded from this is that the first 30 varieties have been susceptible to the more advantageous circumstances on the border, whereas the last 30 have, on the average, not been so.

Besides the above comparison of two-year plants in different situations, we have two smaller sets of one-year plants in the ground, which may be compared with similar plants on the border.

The first of these sets are planted between the standard Bramley apples, and have been used for experiments on liquid dressings during fruiting; but, as will be shown below, these dressings have had no effect on the crop, and the standard trees are too far distant at present to influence the plants. They are planted at the same distance apart as the plants on the border (two feet), but there are six contiguous rows in each strip of ground. There are 144 plants of nearly all the varieties.

TABLE 11.—PERCENTAGE EXCESS (+) OR DEFICIT (−) OF THE CROPS FROM ONE-YEAR STRAWBERRY PLANTS IN THE GROUND, AS COMPARED WITH CROPS FROM ONE-YEAR PLANTS IN THE BORDER.

Plants in Standard Apple Plot.

Variety.	Difference per cent.	Variety.	Difference per cent.
Enchantress	− 76	Empress of India	− 70
Sensation	− 19	Kitley's Goliath	+ 42
The Albert	− 46	La Constante	+ 36
Scarlet Queen	− 57	Noble	− 14
Crescent Seedling	+ 30	Leader	+ 23
Dr. Hogg	− 56	Pioneer	+ 12
Laxton's No. 1	− 23	Waterloo	+ 40
Latest of All	− 46	Mrs. Laxton	+ 8
Auguste Nicaise	− 67		
Monarch	− 46	(Old Pine	+218)*
Loxford Hall	− 39	(Elton Pine	+123)*
Ed. Lefort	− 25	(Stevens' Wonder	+216)*

Mean − 19·7.

* Omitted in the mean.

Plants in Demonstration Plot.

Variety.	Difference per cent.	Variety.	Difference per cent.
J. Veitch ($1\frac{1}{2}$ × 2 ft.)	− 67	Alice Maud ($1\frac{1}{2}$ × 2 ft.)	− 41
Sir J. Paxton „ -	− 58	Keens' Seedling „ -	+ 14
British Queen „ -	− 86	Preston Seedling „ -	− 37
Vic. H. de Thury „ -	− 44		
Royal Sovereign „ -	− 55	Noble ($1\frac{1}{2}$ × $1\frac{1}{2}$ ft.) -	−29 } −10*
Sir C. Napier „ -	− 61	„ (1 × 1 ft.) -	+10 }
	Mean − 44·5.		

* Omitted in the mean.

The differences between the crop from these and from the "border" plants are given in the first half of Table 11. It will be seen that, as in the case of the two-year plants, the yield is considerably lower than on the border, the mean deficit being 19·7 per cent. (The results with the last three varieties are evidently exceptional, and have been omitted in the mean; the "border" plants of these varieties gave so small a crop as to be useless for purposes of comparison.) As in the case of the two-year plants, the heaviest croppers on the border are those which show the greatest difference when compared with their fellows in the ground. The average deficit with the first 10 in the list (which is arranged according to the order of cropping on the border) is − 40·6 per cent., while, with the second 10, there is an average increase of + 1·3 per cent. These mean values are all remarkably close to those observed with the two-year plants, and even more concordant values (− 24 and − 27 per cent. with the one- and two-year plants respectively) are obtained if we confine our attention to those varieties only which appear in both lists.

The second set of one-year plants in the ground are those in the Growers' Demonstration Plot, where there are about 600 plants of each of 10 varieties. They have been treated in the same way as the other plants, but, being planted closer together, each plant has received less manure, in the majority of cases only three-quarters of that received by the other plants, and in the case of Noble, where the distances were still more reduced, nine-sixteenths of this amount per plant was received in one case, and one-quarter in the other. Whether the results are due to this deficit of manure, or are more direct consequences of close planting, and of the proximity of the trees and bushes, it is impossible to say; but the yield falls much further below that of the "border" plants than in the case of the other plants in the ground, the deficit being 44·5, instead of 19·7 per cent., and, in the two cases where the distances with the same variety have been varied, those which are planted most closely have given the worst yield.

In Table 12 we have given lists of the first 20 plants, which, according to our present results, stand highest for bearing, size of fruit, increase of crop with age, or absence of deterioration of the size of fruit with age. The numbers preceding the names indicate the flavour, and those following them the character of the fruit. It would be possible to combine these lists into one, which would give the relative value of the varieties for general purposes, but, seeing that our results depend on the crop of one season only, this would hardly be worth doing at present.

It is curious to note that in no single case does any variety appear in all of the lists given, and

Table 12.—List of the Twenty Best Varieties according to Different Properties.

Cropping Power.				Size of Berry—One- and Two-year Plants.		Lasting Power as measured by				Best for Flavour and Character.†
Border—One- and Two-year Plants.		Ground—Two-year Plants.				Increase in Crop.		Smallness of Decrease in size of Berry.		
2	*Marguerite. 3	1	Thury. 1	2	Noble. 3	2	La France. 2	2	Bossuet. 3	B. Queen.
3	Veitch. 1	2	Bothwell. 1	3	Lesuir. 2	1	Ed. Lefort. 1	1	Elton. 1	Paxton.
2	Enchantress. 1	2	Stirling. 1	2	H. Gloede. 2	2	E. of India. 1	4	Pauline. 2	Hogg.
2	Teutonia. 2	2	Crescent. 1	3	Veitch. 1	2	Filbert. 1	2	Amateur. 2	Thury.
3	Sir Harry. 3	1	Constante. 1	2	Waterloo. 3	2	Amateur. 2	3	Lucas. 2	Nicaise.
1	J. Paxton. 1	2	Kitley's. 2	3	Sensation. 3	2	Fritz. 2	2	Barron. 2	R. Sovereign.
2	K. of Earlies. 1	1	J. Paxton. 1	2	McMahon. 1	2	Bossuet. 3	2	K. of Earlies. 1	Lefort.
3	Jubilee. 3	2	Dundas. 1	2	Marguerite. 3	2	E. Eugénie. 2	2	Ld. Napier. 1	Constante.
2	*Cockscomb. 2	2	No. 1. 1	2	Captain. 1	2	Preston. 1	2	No. 1. 1	Sucrée.
2	Bothwell. 1	3	Mrs. Laxton. 3	2	La France. 2	2	Stirling. 1	2	Noble. 3	Old Pine.
3	Sensation. 3	2	Ruskin. 2	3	White Kt. 3	2	No. 1. 1	2	Crescent. 1	Monarch.
3	White Kt. 3	2	McMahon. 1	2	Dundas. 1	3	Mrs. Laxton. 3	2·5	Black Prince.	Leader.
5	British Qu. 1	3	Competitor. 2	2	Bossuet. 3	1	Paxton. 1	3	*Bubach. 2	Elton.
2	Ld. Suffield. 1	3	Sensation. 3	2	Teutonia. 2	2	Waterloo. 3	2	Waterloo. 3	
2	McMahon. 1	1	Old Pine. 1	1	R. Sovereign. 1	2·5	Keens'. 1	1	Lefort. 1	
2	Scarlet Qu. 2	3	Delacour. 3	2	E. of India. 1	1	Nicaise. 1	3	Jubilee. 3	
2	Crescent. 1	2	Barron. 2	1	Nicaise. 1	2	Gunton. 1	2	D. of Edin. (No. 1) 1	
2	President. 1	2	Captain. 1	2	Emp. Eugénie. 2	2	Kitley's. 2	2	Scarlet Qu. 2	
3	Delacour. 3	2·5	Bk. Prince. 1	2	Bothwell. 1	3	O. Hüttig. 2	1	Thury. 1	
3	*Austria. 3	3	Jubilee. 3	3	Competitor. 2	2	Sir C. Napier. 1	2	Pioneer. 1	

* These varieties were not amongst those planted in the "ground."
† The order of arrangement in this column has no signification.

very few of them occur in more than two. If we take only the cropping power and the size of the fruit—the two properties on which we should at the present stage of our inquiry lay most stress—the varieties which appear in both lists of the best 20 are: *Marguerite, *J. Veitch, Teutonia, Bothwell Bank, *Sensation, White Knight, †McMahon, Admiral Dundas, †Competitor and †Captain. Of these the ones marked * do not appear in the first 20 for size in the "ground" plants, and those marked † do not appear in the first 20 for size in the "border" plants.

When we take, in the same way, the worst 20 as regards crop and size of fruit (the details of which are not given in the Table), we find that there are a larger number common to both lists, namely, Lord Napier, Old Pine, Myatt's Prolific, Elton Late Pine, Andrew Desportes and Boothby's Sweetheart; while, as regards increase of crop and of size, the following appear in both lists of the worst 20:—Admiral Dundas, Commander, Sharpless, Alice Maud and Dr. Morere.* It must be remembered, however, that most of these are late varieties, and for such the past season was not favourable.

To Table 12 we have added a list of those varieties which are amongst the first in flavour and also in character.

The varieties which, as second-year plants, have the most extended season (29 days or more) are: Red Alpine, Eleanor, Jubilee, Royal Sovereign, Scarlet Queen, Desportes, Ruskin and Myatt's: while those with the shortest season (18 days or less) are:

* Loxford Hall, Austria, Enchantress, Teutonia and Duke of Edinburgh (No. 2) only just escape being included.

Noble, Lord Napier, Elton, Competitor, Lesuir, Unser Fritz, Loxford Hall, Countess, Mrs. Laxton, Duke of Edinburgh (No. 2) and Austria.

As regards the habit of the plants, the following varieties have been specially noticed as being strong:—*Ruskin, No. 1, Scarlet Queen, Thury, Keens', Royal Sovereign, Sensation, *Alice Maud, Sir Harry, Veitch, Cockscomb, Preston, Bothwell, The Albert, La France, Stirling, Lucas, Duke of Edinburgh (No. 2), Rundle, *Mrs. Laxton, Amateur, Enchantress, Dundas, Constante, Elton, Waterloo, Desportes, Bicton, Monarch and Stevens' Wonder—those with asterisks being especially so; whereas the following varieties appeared to be exceptionally weak growers:—Sharpless, La Grosse Sucrée, Pauline, Austria, Commander, Barron, Countess, H. Gloede, Unser Fritz and Otto Hüttig.

Several varieties, it may be mentioned, flowered freely a second time in August and September, 1896. The most conspicuous in this respect were Noble, La Grosse Sucrée, Teutonia, Preston Seedling, Bothwell Bank, Countess and Lucas: in the case of the last mentioned the flowers were especially profuse, and some of the fruits set, although they did not ripen fully.

Effect of applying Liquid Dressings to Strawberries during the Swelling of the Fruit.

The details of these experiments have been given on p. 35, plots Nos. 501 to 506: it is only necessary to repeat here that dressings, consisting of a litre of water to each plant, either pure or containing some food constituent, were given once a week for a month during the swelling of the fruit. The plot to which no dressing was given was in two portions, at opposite ends of the ground allotted to the experiments, so that it was the

less likely to have yielded anomalous results. There were 528 one-year plants in each plot, and 24 different varieties were represented in each. The following numbers give the percentage excess (+) or deficit (−) of the crops from the various plots, as compared with that from the one which had no dressing:—

501. No Dressing.	502. Water only.	503. Ammonium Sulphate.	504. Sodium Nitrate.	505. Potassium Nitrate.	506. Ammonium and Iron Sulphate.
0	Per cent. −5·6	Per cent. −5·3	Per cent. +1·5	Per cent. −0·8	Per cent. +0·4

The results are certainly surprising, for none of the plots show any appreciable increase to have been produced by the dressing; indeed, the mean from the dressed plots is slightly below (2 per cent.) that from the undressed plot. It is true that the plants were small, and that the average yield per plant was small also (about nine grams), and that the season was an exceptionally dry one; but it might have been expected that all these circumstances would have tended to favour the beneficial effects of liquid dressings, rather than the reverse, and the closeness with which all the values agree with each other—the extreme variation being only 7 per cent.—scarcely admits of the supposition that there is anything faulty in the experiments.

It was thought possible that, although the dressings had not increased the crops, they might have caused them to ripen earlier, but the opposite appears to have been the case, for if, instead of taking the whole crop, we take that portion of it which was gathered during

the first third of the period over which the gathering of each variety extended—if, for instance, a variety was picked on six days, and we take the crop picked on the first two days only—the values with the dressed plots all come out very materially lower than that with the undressed plot, the mean being actually 15·8 per cent. smaller. The details are—

501	502	503	504	505	506
0	Per cent. −15·0	Per cent. −12·7	Per cent. −12·3	Per cent. −21·1	Per cent. −18·0

The results obtained in another season must be awaited with interest, and, as the plants will then be in full bearing, it will be possible to examine the results with each variety separately, instead of taking merely the mean result with all of them as at present.

Effect of Spraying Potatoes and of Planting at different times.

During the last two seasons some spare ground has been utilised by growing different varieties of potatoes in it, one-half of each of the plots being sprayed with Bordeaux mixture, in order to measure the effect produced by it in arresting disease.

Unfortunately, so far as the experiments were concerned, both seasons proved to be very unfavourable for potato-disease, and in was only the later varieties which were affected to any appreciable extent. The results, however, present some features of interest which may be worth recording. The actual weights of the crops from different varieties will be of value, chiefly to those living in the neighbourhood, and we have, therefore, given them in English measures.

In 1895 fifteen different varieties were planted, there being two or three separate plots of several of them in different parts of the ground. They were planted between April 22nd and May 20th. Whole tubers, averaging seven to the pound, were used as seed and these were set at 15 inches apart, in rows three feet from each other. They were hoed and earthed three times. Our mixed manure, at the rate of 790 lbs. to the acre, was applied on planting, and 300 lbs. of sodium nitrate to the acre were applied on June 21st. The Bordeaux mixture was that supplied by Messrs. Strawson & Co., and 12 lbs. of it in 50 gallons of water were used per acre, both on July 1st and on August 19th. The plots varied considerably in size, from 3,330 to 450 feet run of rows of plants, the average being

about 1,000 feet run, representing one-fifteenth of an acre.

Signs of disease were first noticed in The Bruce on September 6th, and at a later date the contrast between the sprayed and unsprayed halves of many of the plots was very marked, it being possible to draw a line exactly by mere inspection at the row where the spraying began. Yet the disease had made such small progress, that the number of diseased tubers which could be found when the crop was lifted, was practically *nil*, the disease, which starts in the leaf, not having had time after the drought ceased to spread to the tubers. But the increase produced on the total weight of the crop by the spraying was in most cases appreciable—an effect which, as is well known, is due to the greater longevity induced in the haulms by the treatment.

In the following table (13) we give the effect produced on the total crop by the spraying, and also that on the portion of the crop which consisted of the larger tubers, comprised under the technical terms of "large" and "sets," as well as the effect on the haulms, in such cases where these had not been affected by frost before digging. The varieties are arranged in the order in which they were lifted.

It will be seen that the average increase on the total crop produced by the spraying is 11·6 per cent., and, on dividing the list of plots roughly into two halves, it is found that this increase is due chiefly to the later varieties, these showing an average increase of 16·7 per cent., whereas the average increase of the earlier varieties is only 6·5 per cent. On looking at the results with the larger tubers only, it will be seen that the percentage increase there is greater throughout than it is with the total crop, showing that spraying

Table 13.—Percentage Increase (+) or Decrease (−) produced in the Tubers and Haulms of Potatoes by Spraying, 1895.

Date of Lifting.	Variety.	Alteration produced by Spraying						Pounds per Foot run. Unsprayed Plots.
		In total Crop.		In "Large" + "Sets."		In Haulms.		
Aug. 12	White Hebron	+25		+53		+43		·167
14	Early Puritan	+11		+14		+ 2		·236
14	„	− 5		− 8		−17		·240
Sept. 10	Schoolmaster	− 2		+ 1		+ 3		·189
13	White Hebron	−30		+24		..		·117
16	Snowdrop	+29		+65		+16		·219
17	Perkin's Snowdrop	+ 5	+ 6·5	+10	+13·3	+ 5	+10·6	·128
21	Findlay's Lady Fife	−19		−15		+30		·273
23	Sutton's Best of All	+16		+ 9		+ 3		·600
Oct. 7	Reading Giant	−10		+13		+ 6		·680
8	Magnum Bonum	−14		−15		+18		·490
9	„	+12		+ 9		− 2		·569
12	Imperator	+ 3	+11·6	+ 3	+16·2	+29		·680
17	Bedfordshire Hero	+28		+53		+55		·354
26	The Bruce	+ 9		+ 8		..		·876
26	„	+42		+31		..		·670
26	„	+18		+23		..		·741
27	Reading Giant	+20		+15		..		·537
28	Clark's Maincrop	+22	+16·7	+28	+19·1	..		·677
30	„	+14		+14		..		·702
30	„	+ 2		+ 8		..		·677
Nov. 1	Laxton's Hero	+ 6		+ 5		..		·570
2	Imperator	+12		+12		..		·364
3	Bouncer	+24		+29		..		·500

not only increases the crop, but also increases the proportion of large tubers in it.

The increase in the weight of haulms is given in another column, and the figures would, no doubt, have been much larger had we been able to include those for the later varieties.

We have also added a column, giving the weight in lbs. per foot run of the rows, which will afford data for the comparative cropping power of the different varieties in our soil. If these values are multiplied by 6·49 they give the crop in tons per acre. The highest crop obtained in any case—one of the plots of The Bruce—amounted to 5·7 tons to the acre, so that the season cannot be regarded as having been a very favourable one for potatoes in our case; this, no doubt, is due to the manure applied not having become available owing to the drought.

In 1896 the experiments were repeated with seven of the above varieties of potatoes, in part of the same ground as that used in the previous year; the seed-potatoes were, also, those which had been grown in this ground. The plots varied between 490 and 960 feet run, and there were two plots of each variety, in one of which the planting took place on the 13th and 14th of April, and in the other, on the 13th and 18th of May. The sprayings were done on June 25th and July 23rd. The crop from each half-plot was stacked separately, and taken out and weighed on January 1st to 6th, 1897. The diseased tubers were weighed in this case. As regards other details, these were the same as in 1895, except that with White Beauty of Hebron and Puritan the rows were only two feet apart.

The results are given in Table 14, the values for the early- and late-planted plots being quoted separately, and refer to the sound tubers only. It will be seen

Table 14.—Percentage Increase (+) or Decrease (−) produced in the Tubers and Haulms of Potatoes by Spraying, 1896.

Date of Lifting.	Variety.	Alteration produced by Spraying						Per cent. Weight of Diseased.		
		In total Crop.		In "Large" + "Sets."		In Haulms.				
		Early.*	Late.*	Early.*	Late.*	Early.*	Late.*	In Sprayed.	In Unsprayed.	Difference.
Sept. 7	Early Puritan	+ 2	− 8	+ 7	− 4	+ 3	− 8	..	..	..
10	White Hebron	− 2	+ 2	+ 1	− 1	+ 26	+ 11	..	..	..
Oct. 10	The Bruce	− 1	− 7	− 2	− 5	+ 48	− 1	3·0	3·5	− 1·5
14	Clark's Maincrop	− 6	− 12	− 12	− 16	+ 3	+ 22	0·5	0·6	− 0·1
22	Reading Giant	− 11	− 6	− 13	− 7	+ 8	0	1·1	1·3	− 0·2
22	Schoolmaster	+ 30	+ 16	+ 22	+ 22	+ 88	+110	0·9	4·9	− 4·0
23	Magnum Bonum	+ 25	+ 17	+ 29	+ 19	+ 34	+ 39	0·5	1·8	− 1·3
	Means	+ 5·3	+ 0·3	+ 4·6	+ 1·1	+ 30·0	+ 24·7			− 1·4
		+ 2·8		+ 2·85		+ 27·4				
		−3·6	−6·2	−3·8	−6·6	+17·6	+4·8			

* Early and late planted.

that, both as regards the late- and the early-planted varieties, there is, on the average, a gain of total crop due to spraying, but that this gain is very small, being only 2·8 per cent., also, that there appears to be no appreciable effect on the size of the tubers, for if the larger ones only ("large" + "sets") are considered, the gain is practically the same as with the whole crops —2·85 per cent. There would appear, however, to be some effect in rendering the tubers more uniform, for when the "sets" only are considered, the average increase produced by the spraying rises to 5·8 per cent. (These values have not been inserted in the table.)

The increase produced by the spraying is practically confined to two varieties—Schoolmaster and Magnum Bonum,—and in their case attains a very considerable magnitude, while with the other five varieties the spraying seems to have produced almost universally a small decrease, and that, too, in spite of the fact that with two of these varieties the haulms have evidently benefited by it. It would be unwise to attach any weight to the small decrease of crop which has been produced in these cases, but the fact that spraying is prejudicial to the crop in cases where disease is absent, or nearly so, has been well established by other observers; it is only where disease is present that spraying results in a gain, through its killing the fungus (*Phytophthora infestans*) which causes the disease.

It is noticeable that the two varieties which have benefited most by the spraying this year were almost unaffected by the treatment in the previous year, so that no conclusion should be drawn as to the behaviour of different varieties without protracted experiments extending over many years.

Another fact which should be noticed is, that the benefit of the spraying is much greater in the early-planted than in the late-planted plots. This, however, may well be due to some peculiarity of the season.

In the last columns of the table we give the percentage of diseased tubers in the crops of the sprayed and unsprayed plots, together with the differences between them. These differences are in every case (except one, where it is *nil*) in favour of the spraying, but they amount on the average to only 1·4 per cent. We have not given the results with the early- and late-planted plots separately, as they were found to be practically identical in every case. The connection between the diminution in the tubers diseased and the increase in the weight of the haulms is well marked.

As to the commercial aspects of spraying, it would obviously be unfair to draw any conclusions from experiments such as the present ones, which were made in two seasons when there was very little disease existing. The total cost of two sprayings may be placed at about 30*s*., and, if the increase produced thereby amounts to 10 per cent. of the total crop, the result will, with an average crop, be a commercial success; and, although in many of our own results an increase of this magnitude was not attained, the large body of experiments made elsewhere proves that 20 to 30 per cent. increase may be expected in a normal season.* With early potatoes spraying does probably more harm than good, owing to the absence of any disease to be combated.

* A large mass of data on this subject will be found in two publications of the Board of Agriculture on "Checking Potato Disease," 1892 and 1893; also in a report by the Irish Land Commission on "Experiments in 1893 on Potato Disease"; and a report by the Wilts County Council on the same subject, 1895.

In Table 15 we give values obtained from a comparison of the crops of the early- and late-planted plots. In five cases the balance is very considerably in favour of early planting, and in one case only is it appreciably in the opposite direction: the mean increase is as much as 27 per cent. over the crop of the late-planted plots, and this value, when the small tubers are excluded from consideration, remains the same. It was also noticed that the potatoes in the late-planted plots were much rougher and more out-grown than the others.

These differences are so considerable, and the results are of such practical importance, that it will be well to repeat and extend the experiments another year.

In the remaining columns of Table 15 we give the weights of the crops from the different varieties in pounds per foot run, together with the values for the same varieties in 1895, for the sake of comparison. We have also converted the actual values into relative values, expressed so that the mean of the crops of the varieties

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We cannot refrain from expressing our regret that the valuable data which are collected in these Government publications should be rendered well-nigh useless by the manner in which they are collated and laid before the public. Each set of original results is reproduced in the particular form in which the different experimenters happened to express them, without any attempt being made to reduce them to uniformity, and no vestige is to be found of any summary which might help the puzzled agriculturist to draw a correct conclusion from a mass of (often) seemingly contradictory results. The weights and measures used present almost as great a diversity as the methods of arranging the results, except that there is a strong predilection for the mediæval monstrosity of expressing a single weight as a compound of as many well-nigh incommensurable quantities as possible—tons, hundredweights, quarters, pounds, &c. Even if the farmer is capable of such feats of mental gymnastics as divisions by 28, 112, $30\frac{1}{4}$, &c., he can hardly be expected to apply these processes to some scores of pages of figures, in order to find out what advantage he may reasonably expect by spraying his potatoes. He will either glance at one or two of the results (perhaps fallacious ones), and draw his conclusions from them alone; or, if he is a wiser man, he will trouble himself no further about matters which are evidently not adapted to his comprehension.

included are represented by 100 in each season; this facilitates a comparison of the cropping powers of the different varieties in the two years. The actual crops in 1896 are, on the average, nearly double those in 1895—a fact which is probably due to the manure applied in 1895 remaining ineffective for that year's crop, owing to the drought, and becoming available for the crop in the succeeding year. Looking at the relative values, it is satisfactory to find that nearly the same order, as regards cropping power, obtains in both seasons, so that any conclusions as to the applicability of certain varieties to the soil in the district are probably correct, even though based on the results obtained in one season only.

TABLE 15.—TOTAL CROPS FROM EARLY- AND LATE-PLANTED POTATO-PLOTS, 1896, AND AVERAGE TOTAL CROPS, 1895 AND 1896.

Variety.	Per cent. Excess (+) or Deficit (−) of Early- compared with Late-planted.		Total Crop.			
			1896.		1895.	
	Total Crop.	"Large" + "Sets."	Lbs. per Foot.	Relative.	Lbs. per Foot.	Relative.
Early Puritan -	+ 39	+ 46	·46	54	·24	55
White Hebron -	+ 69	+ 81	·39	46	·14	32
The Bruce - -	+ 12	+ 11	1·67	196	·76	168
Clark's Maincrop	− 1	− 9	·94	111	·66	150
Reading Giant -	− 31	− 35	1·03	121	·61	138
Schoolmaster -	+ 64	+ 64	·59	69	·19	43
Magnum Bonum -	+ 40	+ 34	·87	102	·53	120
Mean - -	+ 27	+ 27	·85	100	·44	100

In 1895, when the largest number of varieties were planted, the following were the conclusions drawn as to their respective merits :—

For quality these were satisfactory : White Hebron Perkin's Snowdrop, Laxton's Hero, The Bruce and Early Puritan. Fairly satisfactory : Schoolmaster, Snowdrop, Clark's Maincrop and Magnum Bonum. Less satisfactory : Sutton's Best of All, Bouncer and Reading Giant. Unsatisfactory : Findlay's Lady Fife and Imperator.

For cropping powers combined with quality, Early Puritan was best amongst the early potatoes, and The Bruce amongst the later ones, Clark's Maincrop and Laxton's Hero coming next.

Experiments on the Germination of Seeds from different-sized Fruits and from Cells containing different Numbers of Seeds.

The following experiments must be regarded as preliminary only, but they afford some valuable suggestions as regards the germinative power of seeds from similar fruits of different sizes, which are well worth further prosecution, both on account of their scientific interest, and on account of their practical importance to those raising new varieties of fruits.

One hundred each of crab-apples, averaging one ounce and half an ounce respectively, were selected, and 60 seeds in each case were taken from cells containing the normal complement of two seeds apiece; 10 seeds in each case were also taken from cells containing one seed only. These seeds were all sown in six similar boxes on January 24th, 1896, and were all treated in a precisely similar manner.

In Table 16 we give the results entered on various dates for each box separately. The first figure in each column gives the number of plants which had germinated and were alive on the date in question, and the second figure expresses the percentage which this number represents of the total seeds sown in the particular case.

A summary of the mean results expressed as percentages is given in Table 17. The first three lines of figures give the percentage differences in the plants raised from the seeds of two-seed and one-seed cells respectively; the first line refers to one-ounce fruits, the second to half-ounce fruits, and the third is the mean of the first two.

Table 16.—Number of Seedlings above Ground and Alive on Different Dates.

From 1-oz. Fruits.

		March 3rd.		March 8th.		March 15th.		April 6th.		April 12th.		Ultimately.		Died after Germination.		Remarks.
		Actual.	P.c.	Actual.	P.c.	Actual.	P.c.	Actual.	P.c.	Actual.	P.c.	Actual.	P.c.	Actual.	P.c.	
One-seed cells.	Box A (10 seeds)	0		0 = 0		4 = 40		5 = 50		5 = 50		4 = 40		1 = 10		Irregular.
	„ B „ -	0		1 = 10		4 = 40		8 = 80		8 = 80		7 = 70		1 = 10		Medium.
	„ C „ -	0		2 = 20		3 = 30		3 = 30		4 = 40		4 = 40		0 = 0		Weakly.
	Mean - -	0		1 = 10		3·7 = 37		5·3 = 53		5·7 = 57		5 = 50		0·7 = 7		
Two-seed cells.	Box A (60 seeds)	1 = 2		2 = 3		20 = 12		20 = 33		20 = 33		18 = 30		2 = 3		Very uneven.
	„ B „ -	6 = 10		6 = 10		35 = 22		35 = 58		37 = 62		33 = 55		4 = 7		Irregular.
	„ C „ -	2 = 3		4 = 7		31 = 27		31 = 52		31 = 52		27 = 45		3 = 7		„
	Mean - -	3 = 5		4 = 7		29 = 20		29 = 48		29 = 49		26 = 43		3·6 = 6		

From ½ oz. Fruits.

One-seed cells.	Box D (10 seeds)	1 = 10		4 = 40		9 = 90		9 = 90		9 = 90		9 = 90		0		Strong and even.
	„ E „ -	3 = 30		5 = 50		7 = 60		7 = 70		7 = 70		7 = 70		0		„ „
	„ F „ -	0 = 0		0 = 0		4 = 10		4 = 40		5 = 50		5 = 50		0		Medium.
	Mean - -	1·3 = 13		3 = 30		6·7 = 53		6·7 = 67		7 = 70		7 = 70		0		
Two-seed cells.	Box D (60 seeds)	20 = 33		34 = 57		49 = 68		49 = 82		49 = 82		47 = 78		2 = 3		Strong and even.
	„ E „ -	24 = 40		34 = 57		51 = 75		51 = 85		53 = 88		53 = 88		0 = 0		„ „
	„ F „ -	6 = 10		14 = 23		44 = 43		44 = 73		45 = 75		44 = 73		1 = 2		Rather irregular.
	Mean - -	17 = 28		27 = 45		48 = 62		48 = 80		49 = 82		48 = 80		1 = 2		

TABLE 17.—SUMMARY OF RESULTS OF GERMINATION.
Percentages—Mean Values.

——	Mar. 3.	Mar. 8.	Mar. 15.	Apr. 6.	Apr. 12.	Ultimate.	——
Results from two-seed cells less those from one-seed cells.	+ 5	− 3	− 17	− 5	− 8	− 7	1-oz. fruits.
	+15	+ 16	+ 9	+ 13	+ 12	+ 10	½-oz. fruits.
	+10	+ 7	− 4	+ 4	− 2	− 2	Mean.
Results from ½-oz. fruits less those from 1 oz. fruits.	+13	+ 20	+ 16	+ 14	+ 13	+ 20	One-seed cells.
	+23	+ 38	+ 42	+ 32	+ 33	+ 37	Two-seed cells.
	+18	+ 29	+ 29	+ 23	+ 23	+ 29	Mean.

Looking at the results from the larger fruits (first line) it will be seen that seeds from the one-seed cells are, throughout, somewhat ahead of the others in germinative power, whereas with the smaller fruits (second line) the reverse is the case, the mean result from fruits of all sizes (third line) leaving an inappreciable balance (only 2 per cent. in ultimate survivals) in favour of the two-seed cells.

In the next three lines we have given, in a similar way, the differences between the percentage germination of seeds from half-ounce and one-ounce fruits; and here it will be seen that the differences are by no means negligible, amounting in the mean, as regards ultimate survivals, to 29 per cent. in favour of seeds from the smaller fruits; and, if seeds from two-seed cells only are considered, this balance rises to as much as 37 per cent., or nearly double the value of what it is in the case of seeds from the abnormal one-seed cells. It may also be seen from the "remarks" entered in Table 16 that the seedlings from the smaller fruits were in nearly every case more robust than those from the larger fruits.

These experiments are at present being repeated with other fruits, and also with four sizes of each variety of fruit, and attempts are being made to settle whether it is merely the relative size of the fruits which affects the germinative power of the seeds, or whether the present results are due to one or other of the sizes of fruits selected being abnormal, as compared with the average fruits from the tree, it being conceivable that the average-sized fruit might have the highest germinative power.

Observations on Canker in Plum Trees.

Apparently no observations have yet been recorded of the appearance of *Nectria ditissima* (canker) in plum trees, although from the virulence of an attack of this disease to which our trees have been subjected during the past year it is difficult to imagine that its appearance is a novelty.* The fungus has been identified by Professor Marshall Ward and Mr. George Murray as a form of *Nectria ditissima,* though whether it is identical with that to which canker in apple and other trees is attributed, remains yet to be proved.

The plum trees in the fruit farm showed in many cases evidence of the disease in 1896, but in only two instances had it spread sufficiently to kill the upper half of the tree: in an orchard at Harpenden, however, which is under the management of one of us, the disease has been much more virulent, and it is to the effects observed in this orchard that our remarks will be chiefly confined.

The orchard occupies one acre, and consists mainly of standard plums with dwarf apples and pears, and bush fruits between them. The plums were planted at various times between the autumns of 1892 and of 1895, and in the latter year would vary in age between three and eight years from the graft. Except in a very few instances, the young apple trees in the orchard do not seem to be affected by canker, though

* A passing reference to "brown rot" in a bulletin of one of the American experimental stations is strongly suggestive of a disease identical with that which we have observed.

in an old orchard, some hundred yards distant, canker is very rife. Nothing amiss was noticed with the plum trees till the late autumn of 1895, when it was found that in four or five cases the cortex of a large portion of the stem, or of some of the main branches of certain trees, was entirely dead and rotten. The disease had penetrated a considerable distance into the wood, but had not affected the periderm, so that there was nothing externally to indicate its presence, except that the portions affected had not grown with the rest of the tree, and, therefore, presented a somewhat depressed surface. The cortex in the diseased parts was brownish-yellow and moist, and possessed an offensive odour: a somewhat similar appearance was presented by the wood. The diseased parts were, where possible, removed, and the wounds covered with tar. In two cases the disease had spread entirely round the tree, and these trees, it may be mentioned, came into leaf the following year, flowered and bore fruit, although the foliage was sickly, and the fruit did not ripen properly. During May and June of 1896 it was found that many more trees were succumbing to the disease: a few of these were ones in which the attack had been noticed in the previous autumn, but in the greater number of cases they were not such. The leaves were seen to assume suddenly a yellow tint, and, on examining the tree, it was found that the disease had spread entirely round the trunk. Before the end of the summer 14 trees out of 93 had been killed in this manner, and a much larger number had been affected, rendering extensive surgical operations on them necessary, and involving, sometimes, the removal of half the thickness of the stem. The disease seemed to be absolutely impartial in its

attacks, both as to the age, variety and healthiness of the trees; indeed, some of the healthiest trees in the orchard were killed, and these remained in active growth and full bearing till the disease entirely encircled them. On taking them up the roots appeared to be perfectly healthy. The disease started indiscriminately at any portion between the base of the stem and the branches. The varieties which suffered were: Victoria, Prince Englebert, Black Diamond, Greengage, White Magnum Bonum and Czar. Monarch (and, at Ridgmont, Sandalls) is the only one which has escaped so far. None of the bush plum trees have been attacked at present, but there were very few of them in the orchard in question.

So far as appears at present, a thorough excision of the diseased part has prevented the spread of the fungus; but it is too early to make any definite statements on this point. Observations on the trees lead us to feel very certain that the fungus can spread through the wood as well as through the cambium or cortex; patches of wood showing the disease were repeatedly found where the superincumbent tissues were unaffected, and it would be difficult to say whether the wood or the outer tissues showed more frequently signs of having been first attacked. Hartig ("Diseases of Trees," English edition 1894, p. 92) expresses his conviction that canker can spread through the wood, although he has not definitely proved it to do so.

Another important point which has been very strongly impressed upon us is that external injury does not appear necessary for the entry of the canker spores. It is difficult to prove that the continuity of the periderm of the tree is perfect, but in a very large number of the

instances the canker was rife where no visible injury could be found, and the instances where there was bark-injury, but no infection, seemed equally numerous. This throws doubt on the view that canker is necessarily a wound parasite.

Hartig (*loc. cit.*), in speaking of the attacks of *Nectria ditissima* on various forest trees and the apple, states that it rarely spreads at a greater rate than 1 c.m. ($\frac{1}{2}$ inch) in a year. From what has already been said as to our observations on plum trees, it must have spread in them at a rate some hundred times greater. It is probable that the rate would vary with different hosts.*

* Hartig mentions that canker is found associated with aphides in the case of the beech, and that then it "spreads in the cellular tissues with extraordinary rapidity"; but the aphides here alluded to are species which attack the stems of the trees, and it is scarcely possible that the green aphis, which attacks the leaves and soft tissues only, could have had any association with the canker in the case of our plum trees.

A new form of Evaporimeter.

The various forms of apparatus existing at present for measuring the evaporative power of the atmosphere possess sundry defects, which render the adoption of some simpler and better form of apparatus desirable. The hygrometer (wet and dry bulb thermometers) indicates the degree of moisture of the atmosphere only at the moment of taking the observation, and gives no information as to the amount of evaporation which has occurred during the past 24 hours, while with evaporimeters which effect the latter, some are too inaccurate, and others are too elaborate and expensive for general use. In devising a new form of instrument it has been our object to adopt a form in which the surface from which evaporation occurs shall be as nearly as possible analogous in position to the leaves of a tree.

The moist surface consists of a sheet of tough blotting-paper, filter-paper or linen, measuring 100 by 50 mm. (about 4 by 2 inches), held vertically by means of a moveable copper frame, A B (Fig. 17) in a vessel of water, C D, fitted with a graduated side tube. The sheet of paper or linen ends in a tongue, which dips into the water, and is thus kept moist. The graduations are such that they give the number of units of volume evaporated per unit area of paper exposed. Thus, a fall of 0·24 shows that 0·24 cubic centimetres, or cubic inches, has evaporated from each square centimetre or square inch, of the paper. Our evaporimeter may, therefore, be termed a standard instrument.

It is scarcely necessary to point out that the actual amount of evaporation occurring from any object must depend on the nature of that object, and on the particular

conditions under which it is placed, and that no instrument, therefore, can measure the actual evaporation occurring, except in one particular case; thus, our evapori-

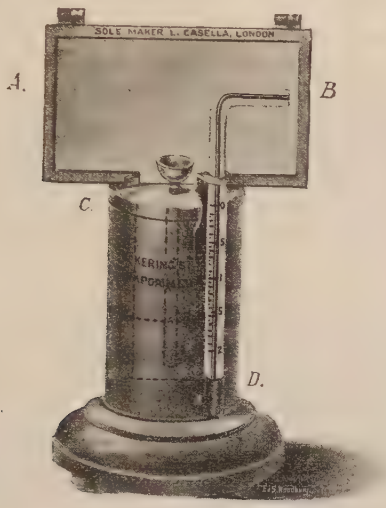

Fig. 17.

meter, like all others, gives only the evaporative power of the air in terms which, though arbitrary, are always the same. It may also be pointed out that, as the paper or linen in our instrument exposes two surfaces from which evaporation occurs, it will give higher values than instruments in which only one surface is exposed.

In adjusting the instrument the paper is first inserted in the frame, and the latter is fixed in the cover, previously removed from the vessel of water. The paper is then wetted, and the cover with the frame placed in position. Before reading the level of the water in the side tube, the paper should be allowed to drain for a few minutes, and the water should be drawn a short distance up the side tube, to make sure that this latter is thoroughly wet. Care should be taken that the side

tube is quite clean, and that there are no air-bubbles in it.

It is, of course, essential that the paper or linen should always be moist all over; if it is found not to be so, this is probably due to greasiness, and a fresh piece of material should be inserted. With papers of the size mentioned, we have never found that they fail to keep moist all over, even on the driest days: it is possible, however, that in other climates this might not be so. In that case the size of the paper would have to be reduced.

In adjusting the instrument it is not necessary that the level of the water should be brought to zero, for we have found, as will be shown below, that the amount of evaporation occurring under the same conditions is independent of the actual level of the water in the reservoir, provided always that there is sufficient there to keep the paper moist.

Distilled water should be used, or, failing that, rain water.

A little evaporation occurs through the aperture in the cover through which the tongue of paper passes: this has been found to amount to about 3 per cent. of the total evaporation when the instrument is in a sheltered position, and such a correction can always be applied, though, as a rule, it will be a negligible quantity.

The temperature should be the same when the instrument is adjusted, and when the amount of evaporation which has occurred is read: if it is not, a fairly accurate correction may be applied (in the case of the instruments as now made) by subtracting from the last reading 0·001 for every degree C., or 0·0005 for every degree F., that the temperature at the last observation

is above that when the instrument was set, or adding these amounts per degree, if the final temperature was lower than the initial temperature.

Both this correction, and that due to the evaporation through the slit in the cover, may be entirely obviated by having a second instrument, similar in every respect to the former, except that evaporation is prevented by a strip of paraffin wax across the neck of the paper. When the apparent evaporation, as indicated by this second instrument, is subtracted from that indicated by the first, we get the true evaporation without further correction.

The use of two instruments in this way also introduces a special advantage into the apparatus, for, since evaporation is prevented in one instrument, while both alike receive any rain which has fallen, we obtain a correct measurement of the evaporation, even on a showery day, and even when the water received by the instrument may be in excess of that lost by it.

By using two similar instruments, both with ungreased papers, one in a Stevenson's screen, and the other in the open, the difference in the evaporative power of the air, with and without the operation of the wind, may be determined. When the instrument is used in an exposed position, linen is preferable to paper, and this may be sewn on to the frame with some copper wire.

We may now give a few of the observations which have been recorded in examining the instrument, and on the results of which are based the statements made above.

Two similar instruments were used in these observations, and they were very nearly, though not exactly, of the dimensions of the apparatus now manufactured. The side tubes were graduated into linear inches, one-

twentieth of an inch being the size of the smallest division marked. The level of the water was read by estimation to 0·01 of an inch or less, and the errors of the readings of the amount of evaporation shown by the two instruments may safely be taken as accounting for differences of 0·02 inch or less, so that where the readings agree within this amount, the two instruments may be taken as yielding the same results within the limits of possible observation. In every pair of observations quoted, the readings were taken simultaneously with the two instruments.

With *different levels of the water* in the reservoirs of the two instruments the evaporation was found to be strictly the same, thus:

Difference of level.	*Evaporation measured.*
0·5 inch.	0·35 and 0·34 inch.
0·8 „	0·375 „ 0·38 „
1·0 „	0·34 „ 0·35 „
1·0 „	0·50 „ 0·515 „
1·0 „	0·35 „ 0·345 „

That the papers may become clogged with various impurities when used for too long a time without being changed, is probable, but the same paper may certainly be used for a fortnight, and probably for much longer, without showing any appreciable deterioration, as the following observation shows:—

With paper which had been in use 2 weeks 0·385 inch.
With fresh paper - - - - 0·375 „

The *nature of the material* used, provided that it is sufficiently bibulous to remain always wet, does not appear to influence the results, thus:

With white blotting-paper - 0·320 inch.
With thick grey filter-paper - 0·325 „

With white blotting-paper - -	0·305 inch.
With thick grey filter-paper -	0·315 „
With white thin filter-paper -	0·265 „
With thick grey filter-paper -	0·245 „
Ditto - - -	0·150 „
	0·150 „
With white thick blotting-paper-	0·135 „
With white thin filter-paper -	0·155 „
With white thin filter-paper -	0·350 „
With linen - - -	0·355 „
Ditto - - -	0·425 „
	0·415 „

The *size of the tongues* of the sheets of paper was also found not to affect the result, thus:

With a tongue 0·6 inch in diam.	0·425 inch.
With a tongue 1·0 inch in diam.	0·390 „
Ditto - - -	0·150 „
	0·155 „

It was also found that no appreciable evaporation occurred from the edges of the sheets of paper which are clipped between the metal frame-work, for the same results were obtained when these edges were greased, as when they were not greased. This is of importance in showing that the true area from which evaporation occurs is determined by taking the inside measurements of the frame.

Edges of paper not greased -	0·615 inch.
Edges of paper greased - -	0·595 „
Ditto - - -	0·325 „
	0·320 „

The following observations are of interest as showing the effect of a heavy shower:—

1st	instrument	0·070	inch	rise	measured.
2nd	„	0·065	„	„	„
1st	„	0·120	„	„	„
2nd	„	0·115	„	„	„

In using frames of different sizes, *i.e.*, in having different areas from which evaporation occurs, anomalous results were obtained, the smaller area always showing more evaporation than might be expected. Thus, a surface measuring 4 by 1 inch should give an amount of evaporation exactly half of that given by a surface 4 by 2 inches, instead of which it was found to show an evaporation 59, instead of 50, per cent of this latter, *i.e.*, about 18 per cent. greater than it should be; and this result was very consistently obtained whether the half-sized paper measured 4 by 1 inch, or 2 by 2 inches: also a direct comparison of these two shapes confirmed the identity of the results given by them. We have made a considerable number of observations, with a view of ascertaining the cause of this discrepancy, but as we have not yet satisfied ourselves on this point, we think it unnecessary to describe them at present. Suffice it to say, that the existence of such a discrepancy will not affect the utility of the instrument, unless it is found necessary to use papers of different sizes under different atmospheric conditions.

Meteorological Records.

Our meteorological records for 18 months are given in Table 18. There are two stations on the ground where observations are taken, these being at the highest and lowest parts of the farm respectively, and the chief interest attaching to the observations lies in the differences observed at the two, for, as is well known, small differences in position will often make very material differences in the welfare of fruit trees. The stations are indicated on the sketch plan (p. 5) by the letters H and L; they are 690 feet distant from each other, and the upper one is 15·3 feet higher than the lower, this latter being within 65 feet of the brook. Neither of the stations is shaded from the sun, except when this is on the point of sinking. At each there is a Stevenson's screen, containing a maximum and minimum thermometer for determining the temperature of the air four feet above the ground, and wet and dry bulb thermometers for measuring the humidity of the air. Near the screens are minimum thermometers four inches above the ground, for measuring the surface temperature of the soil (radiation thermometers), and a thermometer inserted at a depth of six inches below the surface. The latter is not a maximum or minimum instrument, and, therefore, gives the temperature at the time of observation only. There is also a pair of evaporimeters in the open at each station, although observations with them have only lately been commenced, and do not, therefore, figure in the table. The solar radiation thermometer is about the middle of the ground, at Z, and the rain-gauge is at R: the latter is a five-inch gauge placed 8 inches above the surface of the soil.

TABLE 18.—METEOROLOGICAL

Upper station (U) 690 *feet to the north-east*

Months.	Air Temperature 4 ft. above ground (F.).											
	Maximum.				Minimum.				Mean.			
	U.	L.	Diff.		U.	L.	Diff.		U.	L.	Diff.	
1895.												
July - -	69·2	69·7	− ·5		51·5	50·8	+ ·7		60·4	60·3	+ ·1	
August -	69·2	69·4	− ·2		53·1	52·5	+ ·6		61·2	61·0	+ ·2	
September -	71·7	71·9	− ·2		48·4	47·1	+1·3		60·1	59·5	+ ·6	
October -	52·8	53·0	− ·2		37·6	37·4	+ ·2		45·2	45·2	0	
November -	50·9	51·0	− ·1		39·6	39·7	− ·1		45·2	45·3	− ·1	
December -	43·2	43·1	+ ·1		32·9	32·8	+ ·1		38·1	38·0	+ ·1	
Means -	59·68	59·70	− ·18		43·85	43·38	+ ·47		51·70	51·55	+ ·15	
1896.												
January -	44·3	44·4	− ·1		34·5	34·6	− ·1		39·4	39·5	− ·1	
February -	44·5	44·5	0		32·7	32·7	0		38·6	38·6	0	
March - -	51·0	51·2	− ·2		37·0	37·2	− ·2		44·0	44·2	− ·2	
April - -	53·9	53·1	+ ·8		37·4	36·9	+ ·5		45·6	45·0	+ ·6	
May - -	63·1	63·1	0		41·2	40·7	+ ·5		52·1	51·9	+ ·2	
June - -	71·3	71·8	− ·5	−·33	50·8	50·2	+ ·6	+·48	61·1	61·0	+ ·1	+·05
July - -	73·6	73·9	− ·3		51·4	51·0	+ ·4		62·5	62·5	0	
August -	66·9	67·4	− ·5		48·8	48·4	+ ·4		57·8	57·9	− ·1	
September -	62·5	62·5	0		50·3	50·2	+ ·1		56·4	56·4	0	
October - -	51·9	51·9	0		38·5	38·3	+ ·2		45·2	45·1	+ ·1	
November -	44·8	44·8	0		33·0	32·8	+ ·2		38·9	38·8	+ ·1	
December -	42·9	42·7	+ ·2		33·4	32·5	+ ·9		38·1	37·6	+ ·5	
Means -	55·89	55·94	− ·05		40·75	40·46	+0·29		48·31	48·20	+0·11	
Means for the Second Six Months -	57·10	57·20	− ·10		42·57	42·20	+0·37		49·82	49·72	+0·10	

* Readings at 9 a.m. † Total rainfall.

Observations, 1895 and 1896.

of lower station (L), *and* 15·3 *feet higher.*

Ground Surface (Radiation) Minimum Temperature.			Earth Temperature* 6 ins. below Surface.			Humidity of Air.*			Solar Radiation.	Rainfall.
U.	L.	Diff.	U.	L.	Diff.	U.	L.	Diff.		
49·9	50·2	− ·3	63·4	62·0	+1·4	73·2	74·5	−1·3	127·4	4·31
49·6	50·5	− ·9	60·7	60·6	+0·1	78·4	79·8	−1·4	128·9	2·76
46·4	43·9	+2·5	59·7	59·6	+0·1	83·2	83·6	−0 4	126·8	0·86
35·7	34·3	+1·4	46·7	47·7	−1·0	86·4	84·9	+1·5	92·2	2·41
34·6	33·2	+1 4	44·1	44·9	−0·8	92·5	93·0	−0·5	77·3	3·76
29·4	28·4	+1·0	38·0	39·3	−1·3	93·0	92·0	+1·0	64·5	1·90†
40·93	40·08	+0·85	52·10	52·35	−0·25	84·7	84·9	−0·2	102·9	16·00
33·3	31·2	+2·1	39·0	39·8	−0·8	96·5‡	96·5‡	0‡	67·1	1·60
30·3	28·9	+1·4	38·6	39·0	−0·4	92·5	92·5	0	79·0	0·36
35·3	33·6	+1·7	42·5	43·0	−0·5	89·5	88·5	+1·0	95·7	2·92
32·9	30·9	+2·0	46·6	46·7	−0·1	79·7	80·5	−0·8	112·1	1·61
38·6	37·4	+1·2	55·4	53·9	+1·5	70·4	69·8	+0·6	120·7	0·37
49·7	48·3	+1·4	63·2	61·2	+2·0	69·5	67·0	+2·5	128·3	1·98
50·1	48·3	+1·8	65·4	62·9	+2·5	66·5	67·5	−1·0	124·4	0·88
47·8	46·3	+1·5	59·0	58·5	+0·5	74·5	77·0	−2·5	121·2	1·82
49·0	48·6	+0·4	51·5	52 8	−1·3	87·5	86·5	+1·0	103·0	6·91
37·4	36·9	+0·5	45·5	47·0	−1·5	94·5	92·0	+2·5	89·7	3·45
31·1	30·4	+0·7	38·7	40·3	−1·6	93·5	94·0	−0·5	75·3	1·08
31·3	30·2	+1·1	37·5	38·4	−0·9	95·0	95·0	0	63·1	3·57
38·90	37·59	+1·58	48·58	48·63	+0·05	84·1	83·9	+0·2	98·3	29·95†
41·12	40·12	+1·00	49·60	49·98	−0·38	85·2	85·3	−0·1	96·1	17·71†

(+1·48 spans the three Diff. rows 49·7 / 50·1 / 47·8; +1·63 spans the three Diff. rows 63·2 / 65·4 / 59·0.)

‡ These values are those obtained in January 1897, the instruments having been out of order during January 1896.

a p. 5387.

M

In the table we give the means for the last six months of 1896, as well as the annual means, for the sake of comparison, if required, with the results of 1895.

In the columns of differences the sign + indicates that the values at the upper station are greater than those at the lower, and *vice versâ*.

On looking at the mean annual temperature of the air for 1896 it will be seen that it is very nearly the same at the two stations; the difference is only 0·11° F., the upper station being the warmer to this extent, but this is due chiefly to the minimum temperatures being higher at the upper station (to the extent of 0·29°), for the maximum temperatures here are rather lower (0·05°) than they are at the lower station. In other words, the variations in temperature of the air on the higher ground are less than they are on the lower to the extent of 0·34 on the average; and if we consider the four summer months only, the differences are much more marked, the variation being 0·81° less at the higher station: the maximum is 0·33° lower, and the minimum 0·48° higher. These differences are, no doubt, due, either entirely or in part, to the freer circulation of air which must occur at the higher station, and they are scarcely sufficient in extent to have any appreciable effect on the trees.

The thermometers at the surface of the ground must be regarded as being influenced by the temperature of the air, and also by that of the ground, which becomes cooled below the air by radiation during the night. The difference in the air temperature would account for a difference of + 0·29 between these minimum thermometers on the ground, but the actual difference observed, it will be seen, was + 1·58 (*i.e.*, the ground temperature at the lower station was lower by that amount), so that

radiation, or some other cooling influence, must have been more potent on the lower than on the higher ground. No material difference is noticeable between the results at different times of year, the value for the summer months being practically the same as that for the whole year. It should be mentioned that, owing to imperfections in the radiation thermometers used during the greater part of the period, corrections which were of a rather uncertain nature had to be applied to the observed readings, so that too much stress must not be laid on the present results; but they are such as might well follow from the air at the lower station circulating less freely there than at the higher station, and thus favouring loss of heat by radiation. A similar difference in the case of the leaves and blossoms of a tree might, at certain seasons, just determine whether they would be nipped by frost or not, especially when we remember that the difference will on many occasions be far greater than the above-mentioned mean annual difference. It would thus appear probable that it is due to increased radiation, and not to excess of moisture, that trees suffer more in low than in high situations.

A further very striking argument in support of this view is afforded by the direct determination of the humidity of the air, for, as will be seen, the humidity is, on the average, practically the same at both stations, there being a difference of only 0·2°, and that, too, in a direction indicating greater humidity at the upper station. This is certainly somewhat unexpected, especially when we consider the proximity of the brook to the lower station.

The only other data to be noticed are those of the earth temperatures taken at 9 a.m. The annual average, it will be seen, is all but identical for the two stations,

the difference being only + 0·05°. It is considerably higher, however, during the summer months, and this is probably due to the fact that the greater dryness and porosity of the soil at the higher station allows of its becoming more readily penetrated by the warm air above it. It will be noticed that the average earth temperature at this depth is almost identical with, though slightly higher than, the average mean air temperature.

Different Arrangement of Trees.

The relative merits of different methods of arranging trees in a plantation was a question which naturally presented itself to us before laying out our ground. The advantages of planting the trees in rows at right angles to each other must be obvious in any experimental work, both on account of its simplicity and on account of the economy of space effected by it; yet it is generally held by horticulturists to be a less advantageous arrangement for the trees than the quincunx arrangement. So far as we can see, however, the superiority of this latter arrangement is very doubtful, and is certainly not sufficient to justify any sacrifices in order to adopt it. As the question is too complex to admit of any satisfactory solution on paper, we have started some experiments by which an answer will be obtained practically.

The relationship between some of the simpler possible arrangements of the same number of trees in a given area may be traced very easily. The various arrangements mentioned being all regular ones, each tree will have the same amount of space at its disposal. We may start with a rectangular arrangement, such as that in Fig. 18, A, in which the distances between the consecutive trees in the horizontal rows are twice as great as those between the consecutive trees in the vertical rows. We may call these distances, for convenience, 10 and 5 respectively. On shifting the alternate horizontal rows a distance of 5 to the right or left, we get the quincunx arrangement B, which, however, is also a square arrangement, as will be evident when the drawing is turned round through an angle of 45°, B′ being thus obtained. The distance between the

consecutive trees in the horizontal and vertical rows here is 7·07. Lastly, by shifting the alternate diagonal lines in B, or the alternate vertical lines in B′, a distance of 3·035, we get an opposite vacancy arrangement, shown in C, which may be best termed an

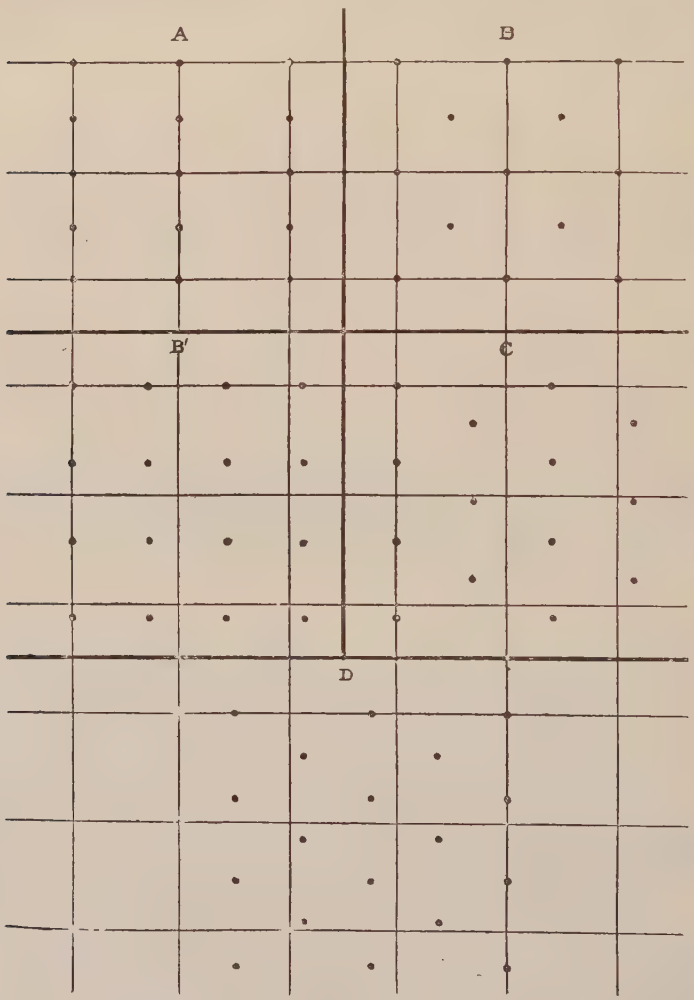

Fig. 18.

hexagonal arrangement, since any selected tree in it is immediately surrounded by six others. These six trees, however, do not form a regular hexagon; two of them are 7·07 distant from the central tree, whilst the remaining four are at a distance of 7·91. To make the hexagon regular, we may, starting with B′, shift all the trees in the vertical lines a little further apart from each other, and all those in the horizontal lines a little nearer to each other. In order that the number of trees per unit area may remain unaltered by this process, the distance between the trees in the vertical rows will have to be increased to 7·7, and that between the trees in the horizontal rows diminished to 6·25 (these distances are, respectively, $\frac{1}{1-x}$ and $1-x$ times the original distances in the square arrangement); then, on lowering the alternate rows as before, a perfectly regular hexagonal arrangement, D, is obtained. This is sometimes called the equilateral-triangular arrangement, and is also familiar to everyone as being the arrangement existing in the honeycomb—a result there of the fact that it permits each bee to be equidistant from all its neighbours who are working in contract with its cell.

It will be seen that any tree in the plantation designed on the square system B′ is surrounded by four other trees as nearest neighbours, at a distance which we have called 7·07, whereas on the hexagonal arrangement the distance of the nearest neighbours will be about one-tenth greater, namely, 7·7, but instead of there being only four of them, there are six; and it must at present remain an open question how far this increase in the number of a tree's immediate neighbours counterbalances the increased distance at which they stand. We might take it as a probably correct assumption that the

prejudicial effect varies inversely as the square of the distance, and directly as the number of the neighbouring trees—in which case the square method would appear to be considerably more advantageous than the hexagonal;* but some effect is no doubt produced by trees further off than the *nearest* neighbours, and without knowing to what distance the influence extends, any calculations of this sort must be very uncertain.

To test the matter practically we have made three plantations of plum trees—one on the rectangular system similar to A, the second on the square system, B or B′, and the third on the hexagonal system, D. Each plantation consists of 36 trees, 12 of each of three different varieties, and the plantations are extended two or three rows beyond the 36 experimental trees, so that these latter may all be well within the body of the plantations. The distance of the nearest neighbours of any tree in the three plantations is 4·24, 6·0 and 6·53 feet respectively, although, of course, the trees have all the same *space* at their disposal, there being the same number of trees per acre in each arrangement.

A theoretically perfect tree should throw out its roots and branches equally in all directions, and hence it might be argued that the hexagonal arrangement—which allows each tree a space more nearly approaching to a circle than does any other arrangement—must necessarily be the best: but the best of fruit trees are so far from perfect in this respect, that any such advantage can scarcely apply in practice. On the other hand, there are two very practical advantages which the square system

* On the square system the prejudicial effect would be $\frac{4}{(7\cdot07)^2} = \cdot08$, and on the hexagonal $\frac{6}{(7\cdot7)^2} = \cdot1013$.

presents over the hexagonal. In the planting of a given plot of ground we shall, in most cases, be able to get more trees into it on the former than on the latter system (taking the same number of trees *per acre* in both cases), for it is only if the plot had some unusual outline, such as that of a hexagon or equilateral triangle, that we could fill it entirely on the hexagonal system ; and, secondly, the square system presents wider alleys between the trees for the working of a horse-hoe, &c., than does the hexagonal, the width of these alleys in the two cases being as 7·07 to 6·67, or, in our plantations, 6 feet and 5·66 feet, respectively.

As it will take some years for our plantations to become sufficiently crowded to show any material differences due to the different systems of arrangement, we have attempted to obtain some results more quickly as regards the square and hexagonal systems, by imitating and exaggerating the conditions which would obtain in over-crowded plantations arranged in these two ways, by surrounding certain trees with screens, instead of with other trees. In 469 and 470 there are six trees surrounded by four canvas screens, as they would be by trees on the square method of planting, and in 471 there are six trees surrounded by six screens, as in the hexagonal method. The screens are of the same height and breadth as the average height and breadth of the trees after pruning, and in the square arrangement they are placed at a distance from the tree of half the average height of the trees. In the hexagonal arrangement they are placed at $\frac{7 \cdot 7}{7 \cdot 07}$ times this distance.

The trees in these experiments are sufficiently far apart (12 feet) to prevent any interference of their

roots, so that the results obtained will give the advantages of the two methods of arrangement with respect only to shading from light and shelter from wind. The shading and sheltering effected by these screens is, no doubt, greater than that effected by trees in any ordinary crowded plantation.

The question of the direction in which the rows of trees should be planted is, doubtless, of importance, but it is one to which a satisfactory answer can probably be obtained only by direct experiment. If the rows run so that each tree has one of its nearest neighbours due south of it, then it will be shaded for a shorter period, and to a lesser height from the ground, but at a time of day when the sun is more powerful, than it would be if its nearest neighbours were south-west and south-east of it. In which direction, however, the balance of advantage lies, is not clear.

To examine this we have, in plot 469, placed the screens north, east, south and west of the trees, whereas, in plot 470, they are placed in the intermediate positions.

APPENDIX A.

Summary of the Experimental Results.

The following summary is only intended to give a general outline of the observations recorded up to the present time, a detailed account of them having been given in the above Report.

Apples.

In the first season after planting (1895) the dwarf apple trees in the experimental plots flowered freely, but were not allowed to bear fruit; and in 1896, although the crop was as heavy as could reasonably be expected from trees of such an age, it was too small in quantity to lead to any trustworthy results as to the value of the different treatment adopted in the various cases.

The growth of young trees is, however, an important matter, even more so than their fruiting, and various features have been examined with a view to measure the vigour of this growth. Thus, measurements have been made of—

1—Size of leaf,
2—Total leaf-area per tree,
3—Length of shoots,
4—Number of shoots,

and, in a few instances, the weight of the leaves.

It is improbable that any particular method of treatment would affect all these various characters to the same extent, and it is possible that it might even affect some of them in opposite directions, yet a certain amount of general agreement is essential, in order to show that the methods themselves are reliable. Such an agreement has been found to exist, and, moreover, has been found to be much more general than might have been anticipated; indeed, it was so general, that in future it will not be necessary to examine more than one of the above characters, except in special cases.

The bulk of the measurements were made in 1896, although in some cases measurements had been made in 1895 also. The results obtained in each plot are compared with those in the plots where the trees had received normal treatment. The values for these normal plots (which are distributed throughout the plantation) were plotted out, and a smoothed curve drawn through them. By taking readings from this curve, the normal values for any part of the ground could be ascertained. There is, on the whole, a

general increase in vigour of the trees—as shown both by the leaf-size and the wood-growth—as we pass from the higher to the lower ground.

The leaf-size was determined by measuring the length and breadth of the sixth leaf from the ends of six shoots on each tree The total leaf-area was obtained by multiplying the leaf-size by the number of leaves on the tree, and the wood-growth is the total length of new wood formed during the season. It is immaterial whether the leaf-size or total leaf-area, when determined as above, are correct absolute measurements or not, since they are only used for comparison with other measurements made in the same way with the normal trees.

Although, in the majority of cases, the present experiments were confined to three varieties of bush apples on the paradise stock, several of them have been repeated on standard apples on the crab stock, and a few of them on dwarf pears and standard plums.

It appears that the growth is affected by beneficial or injurious treatment to a much greater extent than is the leaf-size, and, moreover, that unless the special treatment affects the wood-growth to the extent of nearly 50 per cent., there is, in most cases, no effect at all on the leaf-size.

Of the different methods of treatment, careless planting, coupled with subsequent neglect, gives, as might naturally be expected, the most marked effect, the loss of growth in 1895 being 93 per cent., the loss of leaf-size 75 per cent., and that of total leaf-area 84 per cent. The crop of fruit from these trees in the following year was practically *nil*—not 5 per cent. of that from the normal trees. As to the separate items constituting neglect, it was found that in the second year, when the loss of leaf-size caused by total neglect amounted to 56 per cent., that caused by the growth of weeds over the roots was 44 per cent. in leaf-size, by careless planting with subsequent attention 25 per cent., by planting in untrenched ground 17 per cent., and by the absence of manure 23 per cent.

One set of trees which had been carelessly planted and neglected were subsequently tended in the early part of 1896, and it was found that in the autumn of that year they were only 10 per cent. behind their normally-treated neighbours, thus showing that the response to proper attention is very prompt.

The growth of grass around young apple trees produced a very striking effect. The reduction in size of leaf thus caused was 35 per cent. for dwarf trees, and 41 per cent. for standards, the loss of wood-growth being 87 per cent. for the dwarfs, and 74 per cent. for the standards; in the case of the dwarf trees, too, there was a reduction of 71 per cent. in the weight of the fruit crop. The ill-effect of grass round the trees was much greater than that

of weeds. It is probable, however, that in a wetter year the effect of both grass and weeds would be considerably less than in the past dry seasons.

Omitting to cut back trees when planted results in a very large diminution of leaf-size and of growth—24 and 83 per cent. respectively; but the relative merits of cutting back the trees at once after planting, or of postponing this till the following autumn, are not yet quite clear. When the cutting back was deferred, the loss of vigour during the first year was found to be more than made up in the second year, and this could not be explained as an indirect result of the postponement of the operation, through its causing a loss of the fruit-buds and a consequent absence of crop, for the trees were above the average in vigour both as regards their growth, and, also, as regards their leaf-size, whereas it was ascertained in another experiment that, although the growth was increased by non-cropping, the leaf-size was not. Other facts, however, render it probable that the advantage shown by the trees which had been cut back only at the end of the first year after planting, was due to their having been, on the whole, cut to a smaller extent than those which had been cut back at once (these had been pruned in 1896, as well as having been cut back in 1895), and that this smaller amount of cutting had proportioned the branches more exactly to the roots. These are always injured by transplanting, and a just proportionment of branches to roots results, no doubt, in the healthiest condition of the tree. As further evidence in support of this view, it was found that those trees which were cut back on planting, but not afterwards pruned, were more vigorous than similar trees which had been subjected to both these operations, and they were, moreover, in nearly the same condition as those which had been cut back at the end of the first season only, in spite of their having borne a good average crop of fruit.

The different modifications of autumn and summer pruning under trial have not at present led to any very striking conclusions, but root-pruning has, as might naturally be expected, produced immediate results, the trees which were so treated (the first year after planting) showing a loss of 91 per cent. in their growth, and the crop of fruit produced being practically *nil*. In the case of trees which were kept out of the ground for two days before replanting, the loss of vigour was still greater; whereas, on the other hand, trees which had been lifted with as little damage to the roots as possible, experienced a loss of only 22 per cent. in growth, and practically no loss as regards their crop.

As only one application of manure had been made to the experimental plots, and the season had been extremely dry, no

marked effect was to be expected; but the results obtained, though chiefly of a negative character, present peculiarities which will necessitate further investigation. Thus, although an omission of all manure, or a reduction in the amount of it, produced an appreciable reduction in the vigour of the trees, the omission of either of the three main constituents of the manure produced no effect, as if the action of the manure were a purely mechanical one, independent of the chemical nature of its components. On the other hand, stable manure, which might have been expected to have had a greater mechanical action than artificial manure, produced no result whatever. In cases where the trees had been planted in soil mixed with peat, or in rich compost, the growth was found to be considerably increased, but the leaf-size was not affected.

The only other experiments amongst the dwarf apples which need be noticed here are those dealing with the different seasons of planting. One plot of 18 trees was planted in November, 1895, another in January, 1896, and the third in March, 1896, and of these the autumn-planted trees are decidedly less vigorous than either the winter- or the spring-planted ones. This would indicate that the generally received opinion as to the superiority of autumn as the season for planting is erroneous, but the experiments must obviously be repeated before drawing such a conclusion.

Strawberries.

The results obtained in 1896 from the 86 varieties of strawberries planted on the border have been tabulated in the Report, so as to show the actual and relative productiveness and size of fruit of the different varieties at the two ages—one and two years. Details relating to the flavour and character of the fruit, habit of plant, and duration of gathering, are also given.

Considerable differences have been observed in the cropping qualities of the varieties; but the actual weight of crop must not be relied upon alone as an indication of the usefulness of a variety, neither must it be assumed that because certain strawberries have shown better results than others in the Ridgmont soil, and under the conditions prevailing there, they will do equally well elsewhere. Even within the limits of the farm, the same varieties have given different results according to their situation, and there is evidence to prove that the strawberry is very sensitive to slight variations in the conditions under which it is grown.

As examples of the observations, the following may be cited, all the weights being in grams (28·4 = 1 oz.):—

Largest Crops from One-year Plants.

Marguerite	213	grams per plant.
King of the Earlies	206	,, ,,
Enchantress	192	,, ,,
J. Veitch	187	,, ,,
Teutonia	184	,, ,,
Sir Harry	166	,, ,,

Largest Crops from Two-year Plants.

J. Veitch	251	grams per plant.
Enchantress	237	,, ,,
Sensation	228	,, ,,
Marguerite	227	,, ,,
Sir Harry	225	,, ,,
Sir J. Paxton	223	,, ,,

Taking the average of all the varieties (with the omission of a few evidently anomalous cases), the average total weights of the crops from one-year and two-year plants in the same season were as 100 to 168.

The Longest Period of Fruit-gathering.

Red Alpine	80 days.
Eleanor	38 ,,
Jubilee	38 ,,
Royal Sovereign	35 ,,

The *earliest fruits* were gathered from—

Laxton's No. 1	June 3rd.
Crescent Seedling	,, 4th.
Royal Sovereign	,, 4th.
King of the Earlies	,, 5th.

The *latest fruits* were gathered from—

Sir J. Paxton	July 20th.
Souvenir de Kieff	,, ,,
A. F. Barron	,, ,,
Eleanor	,, ,,
Latest of All	,, ,,
(Red Alpine	August 31st.)

The individual berries show a considerable reduction in average weight as the plants get older, the mean weight for all the varieties at the two ages (one and two years) being as 100 to 78.

The *heaviest berries* from one-year plants were borne by—

	Weight in grams per berry.
G. Lesuir - - -	13·6
Helena Gloede - - -	11·7
Stevens' Wonder - -	11·3
Sensation - - -	10·5
Monarch - - -	10·4
Laxton's Noble - - -	10·4

And the *heaviest berries* from the two-year plants were borne by—

Noble - -	9·9 grams.
Waterloo - -	8·6 ,,
Helena Gloede -	7·2 ,,
J. Veitch - -	7·2 ,,
Marguerite - -	6·8 ,,
Sensation - -	6·7 ,,
La France - -	6·7 ,,

The fruiting of one-year plants was found to be 1·66 days earlier than that of the two-year plants, the latter continuing in bearing 3·38 days longer, on the average.

Lists of the best 20 varieties for cropping purposes, for size of berry, for increase of crop, for smallness of decrease in berry, and for flavour and character are given in the body of the report, and it is noteworthy that no one variety is found in all the lists.

About 60 varieties of strawberries are planted in other portions of the farm, and the crops from these, whether one-year or two-year plants, showed a considerable deficit as compared with those from the plants on the border.

One remarkable result is, that the strawberries which were supplied with water and various liquid manures after the fruit was set, showed that no increase whatever in crop had been produced thereby in any case, and that the ripening of the crop had been retarded by the dressings.

Potatoes.

Fifteen varieties of potatoes were grown in spare plots of ground in 1895, half of each plot being sprayed with Bordeaux mixture and half remaining unsprayed. Although the spraying prolonged the vitality of the haulms, very little disease was found in any of the tubers. The average increase in crop resulting from spraying was 11·6 per cent., the increase being 16·7 per cent. with the later varieties, and 6·5 per cent. with the earlier ones. There was a greater percentage of large tubers in the sprayed plots.

In 1896 the experiments were repeated with seven varieties, of each of which two plots were planted (one in April and the other

in May), and half of each plot was sprayed as in the previous year. There was very little disease present again in 1896, and the average gain on the total crop due to spraying was only 2·8 per cent., there being an actual loss in the case of the earlier varieties, and a considerable gain in two of the later ones. The fact that spraying is deleterious in cases where disease is absent has been previously established.

It was found that there was a considerable balance in favour of early planting in the majority of cases, amounting on the average to 27 per cent. of the total crop.

Although the crops in 1896 were nearly double those of 1895, the different varieties grown in the two seasons followed very closely the same order of productiveness.

Meteorological Records.

Records have been taken during 18 months at the highest and the lowest parts of the ground, and show that these two stations, which differ in level by 15·3 feet, are very closely similar as regards mean annual air temperature, earth temperature (6 inches below the surface) and humidity of the air, the last being somewhat remarkable in view of the proximity of the lower station to the brook; but the thermometers on the ground showed that more radiation occurred at night at the lower than at the higher station, and it is, probably, to a loss of heat in this manner that a low position favours the destruction of fruit-blossoms by late spring frosts. The variation of air temperature was found to be less at the higher than at the lower station, and the earth temperature at the former was higher in summer, but lower in winter, than it was at the latter.

APPENDIX B.

Equivalents of English and Metric Measures.

Weight.

1 gram	=	0·0353 oz.
1 kilogram = 1,000 grams	=	2·205 lbs.
1 oz.	=	28·35 grams.
1 lb.	=	454 ,,
1 cwt.	=	50,787 ,, (51 kilos).
1 ton	=	101,574 ,, (1,016 kilos).

Volume.

1 cubic centimetre (c.c.)	=	0·0353 oz.
1 litre = 1,000 c.c.	=	1·76 pints.
1 quart	=	1·136 litres.
1 bushel	=	36·35 ,,

Length.

1 metre (m.)	=	39·37 inches.
1 centimetre = 0·1 metre	=	3·94 ,,
1 millimetre = 0·001 metre	=	0·04 ,,
1 yard	=	0·914 metre.
1 foot	=	0·305 ,,
1 inch	=	0·0254 ,,

Area.

1 square metre	=	1·196 sq. yds. = 10·764 sq. ft.
1 hectare = 10,000 sq. m.	=	2·471 acres.
1 square yard	=	0·914 sq. metre.
1 acre	=	0·4047 hectare.

Grams per square metre	× 0·03226	= ounces per square yard.
Ounces per square yard	× 31·003	= grams per square metre.
Kilos per hectare	× 0·000398	= tons per acre.
Tons per acre	× 2510	= kilos per hectare.

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